Printed on thin paper for overseas circulation.

Engineering Library

The Engineer

VOL. CLXX.—No. 4417 28, ESSEX ST., STRAND, LONDON, W.C.2 SEPTEMBER 6, 1940

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

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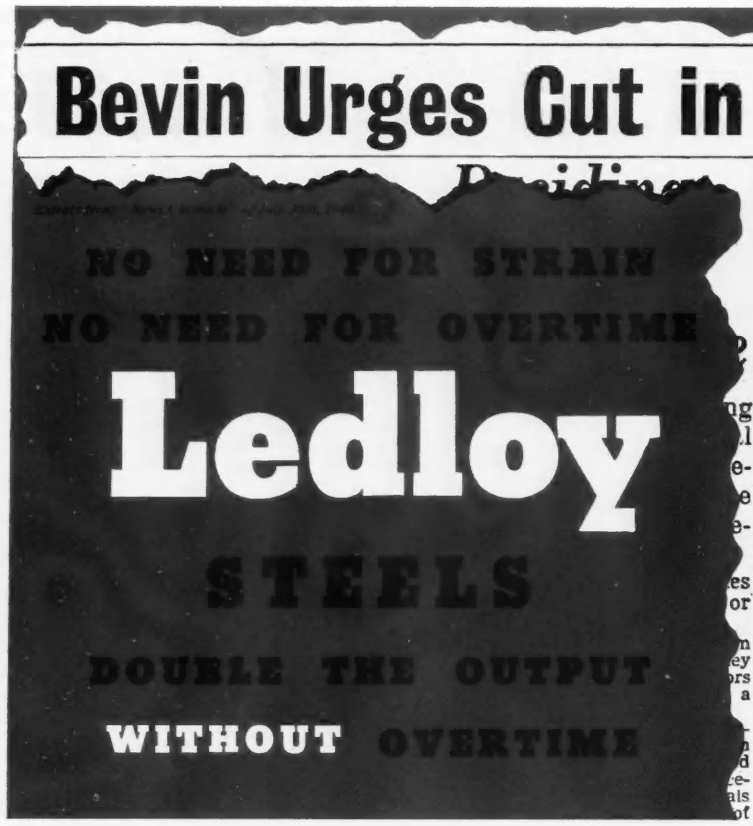

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Bevin Urges Cut in Factory Hours

WORKERS FEELING STRAIN OF PRESENT LONG SPELLS

By IAN MACKAY

MILLIONS of war workers who for the last three months have been working a seven-day 70- to 80-hour week are to have their hours substantially reduced.

The special effort which they made in response to Mr. Bevin's "work like hell" appeal has placed Britain's defences on a secure basis, but men and women cannot go on at top pitch for ever without affecting output.

Mr. Bevin recognised this at the start, and now, in a circular issued for guidance to all firms engaged on war work, he declares that "it is necessary that the average hours of work should be reduced to a lower level."

The ideal is to reach the hours of work that will give the maximum output.

Losses Made Good

At present 70 to 80 hours a week are common in war workshops. This was urgently necessary to make up the losses of material in France.

These losses have been more than made good and the time has come to relieve the strain on the workers.

It is estimated by the Ministry of Labour that a 55- or 56-hour week will be sufficient to keep production up to war pitch as soon as the necessary labour has been acquired and trained.

Big Training Scheme

A Seven-Day Journal

Increases in Railway Costs

IN accordance with paragraph 10 of the White Paper, Cmd. 6168, issued in February, 1940, setting out the agreed financial arrangements for the control of the main line railway companies and the London Passenger Transport Board, the Minister of Transport undertakes to increase charges promptly in order to cover proved increases in costs and the financial effect of certain other war conditions outside the control of the companies and the Board. The estimated increases for the period September 1st, 1939, to September 30th, 1941, amount to £46 millions, and the Consultative Committee appointed to advise the Minister has been asked to consider the best method of increasing charges to cover £44½ millions of the estimated increase in costs by the end of the second year of control. In response to a number of requests the following division of the estimate of £46 millions is given to show approximately the increased costs incurred up to May 1st, 1940, when charges were increased by 10 per cent. (July 1st for the Board) and from those dates to the end of September, 1941 :—

Item.	Total.	Period to 30/4/40 main line companies and 30/6/40 L.P.T.B.	Balance.
	£ millions.	£ millions.	£ millions.
Wages	20·1	3·0	17·1
Allowances to staff serving with H.M. Forces	3·8	1·0	2·8
Materials (including coal)	15·9	3·3	12·6
Other items in connection with conditions arising out of the war	6·2	2·1	4·1
Total	46	9·4	36·6

The First Year at Sea

A REPORT just issued by *Naval Affairs* states that the balance sheet of the first year of the war at sea certainly shows a profit on the side of the British Empire and those lovers of freedom who fight with her. In August, 1939, the German leaders were well aware that their actions would provoke a European war. They sent surface raiders to the more distant trade routes and arranged supply ships for their maintenance on the wide oceans. Thus the "Admiral Graf Spee" met the "Narvik" secretly in the Atlantic on August 28th, 1939. In the initial stages it was not surprising that Great Britain suffered considerable losses of mercantile ships. During the first fortnight of the war twenty-seven British merchant ships, totalling 131,000 tons, were sent to the bottom by U-boats. By the end of that time, however, the convoy system had been introduced and was being rapidly developed, and merchant ships were being defensively armed. Moreover, the British Navy's counter-offensive against the U-boats was taking effect and the losses of British ships fell off abruptly. The British Navy suffered losses at the hands of the enemy, but the U-boat campaign was failing to achieve its object. German submarines then began a ruthless warfare against neutral merchant ships. About the middle of November came Germany's so-called secret weapon, the magnetic mine, but that again failed owing to the genius and devoted work of British scientists and skilled craftsmen. There followed air attacks on shipping. The air attacks on shipping at sea, like the U-boat campaign, and the mining campaign, are proving indecisive and expensive to Germany. Thus in the seven months of war there had been four distinct attacks by Germany upon the vital sea communications of the British Empire. Each one was countered. In the drive into France, which resulted in its collapse, British sea power stood between the German High Command and its boast to wipe out the British Expeditionary Force. Italy has rushed in to aid Germany in the hope of a share of spoil and has lifted the weight of comparative inaction from our Mediterranean Fleet, which is now dealing hammer blows against the weakest part of the Axis.

Employment Returns

IT was officially announced by the Ministry of Labour and National Service on Monday, September 2nd, that between July 15th and August 12th there was a decrease of 27,814 in the number of unemployed persons on the registers of Employment Exchanges in Great Britain. There was a reduction of nearly 50,000 in the numbers of men and women registered as unemployed, but the numbers of boys and girls rose by nearly 22,000, owing mainly to the registration of juveniles who had reached the school-leaving age at the end of the summer term. The total of 799,452 persons registered as unemployed at August 12th was 432,240 less than the figure for August 14th, 1939. There were reductions in unemployment, between July 15th and August 12th in the distributive trades, dock and harbour service, building and public works contracting, clothing manufacture, hotel and boarding house service, the entertainments and sports industries and shipping service. On the other hand, there were increases in unemployment in pottery and earthenware manufacture, the woollen and worsted industry, the hosiery industry, and boot and shoe manufacture. An analysis of the number of unemployed shows that included in the total of 799,452 on the registers at August 12th there were 303,979 men wholly unemployed, and 75,407 temporarily stopped, these men being normally in regular employment. There were 30,265 unemployed men who are normally in casual employment. Similar figures for boys are 27,168 wholly unemployed, 2603 temporarily stopped, and 91 in casual employment; for women the figures are 235,192, 71,993 and 1554; and for girls 46,817, 4377, and 6. Within the last year the most noticeable increases in employment have taken place in the London, Scotland, Eastern and North-Western and Wales administrative divisions, while employment has decreased in the Midlands and North Midlands areas. Compared with a year ago the most noteworthy increases in employment have occurred in the public works contracting, distributive trades, building, coal mining, engineering, local government service, shipbuilding and repairing, metal goods manufacture trades, and road transport and shipping services.

Hong Kong Built Ship for China Service

A MOTORSHIP of unusual interest is the "Hermelin," a single-screw vessel of 1603 gross tons, which has recently been built and engined by the Hong Kong and Whampoa Dock Company, Ltd., for the China Coast and Far Eastern port service of the Norwegian owners, Kiosterud and Co., of Drammen, Norway. The designs for the ship were drawn up by the Hong Kong shipyard and the principal hull dimensions are as follows:—Length overall, 291ft. 2in.; breadth moulded, 43ft.; depth moulded to shelter deck, 25ft. 6in.; gross tonnage, 1603; deadweight carrying capacity, 2607 tons; bale capacity, 167,500 cubic feet; and contract speed, 12 knots. The propelling machinery was also built by the yard, and it comprises a five-cylinder single-acting two-stroke reversing engine of Harland-B. and W. design, having uniflow scavenge with exhaust poppet valves. It has a designed output of 1390 to 1700 S.H.P. when running at speeds of 130 to 160 r.p.m. respectively, the cylinders having a bore of 500 mm. with a stroke of 900 mm. The pumps and other auxiliaries are separate from the engine and they include a Paxman-Ricardo oil engine-driven Reavell air compressor, Lee-Howl circulation, salt and fresh water pumps, and other service pumps by the Mirrlees Watson Company, Ltd., and the Albany Company. The engines are fresh water cooled. On the trials which were carried out over the Hong Kong measured mile with the ship in ballast condition, a mean speed of 13·65 knots was recorded at an engine speed of 148 r.p.m. The loaded contract speed is 12 knots. After the speed trials the "Hermelin" completed a successful sea trial of eight hours' duration. In addition to the well-designed cargo-carrying facilities, there is excellent accommodation for ten passengers in five two-berth staterooms.

Higher Railway Charges Inquiry

THE public inquiry into the proposed increase in railway fares held by the Charges (Railway Control) Consultative Committee, under the chairmanship of Mr. W. Bruce Thomas, K.C., was continued on Monday, September 2nd, at Brooklyn Hall, Bush House, Aldwych. On the first day discussion mainly centred around the additional information given by the Minister of Transport, reproduced in another Journal note herewith. Sir William Wood, who returned to give evidence for the Railway Executive Committee, said that with regard to figures of costs the difficulty was that they could not give figures other than for four-weekly periods. Sir William was questioned at length by Mr. Comyns Carr, representing coal and coke interests, and answered questions on freight charges and estimates. Mr. Comyns Carr purported to show that of the £44,500,000 sought to be found by rail and road increases, £17,000,000 was already accounted for on the estimates already before him, leaving £27,500,000 to be raised by increased fares and rates. Sir William further pointed out that the figures which the Executive Committee had submitted had been examined by the Minister's experts in detail and had been substantiated by the Ministry of Transport. At the session on Tuesday, September 3rd, Mr. Lionel Jellinek, representing the London Co-operative Society, protested that increases in railway fares might be a step towards inflation. On the question of passenger fares Sir William stated that not one person in a million took out other than season tickets, workmen's or cheap daily tickets to travel to work. He still thought it desirable to make an all-round increase. Inflation must, he said, be dealt with on much wider lines than on railway rates only. Mr. Jellinek also suggested that as higher railway rates would mean a higher cost of food, there was a possibility that the man living in the suburbs, finding himself faced with higher railway fares and dearer food, would either have to press for an increase of wages or see his children lack the comforts they should have. Mr. W. J. Lovell, who represented the Commercial Travellers' Association, said that, of some 100,000 commercial travellers, a large number had gone back to the railways because of petrol restriction and a further 50,000 would probably return to the railways next year. Taking their expenditure on rail fares at £3 a week each, that would yield an additional £7,000,000. The inquiry was adjourned till Wednesday, September 4th.

American Destroyers for Britain

ON Wednesday, September 4th, it was announced by President Roosevelt, in a message to Congress, and also in a British White Paper, that the United States is to transfer for immediate use fifty over-age destroyers to the Royal Navy. Great Britain will lease, without charge, naval and air bases in British Possessions in the Northern and Southern Atlantic. Particulars contained in the White Paper refer to bases on the Avalon Peninsula and on the southern coast of Newfoundland, and on the east coast and on the Great Bay of Bermuda. Other bases are on the eastern side of the Bahamas, the southern coast of Jamaica, the western coast of St. Lucia, the west coast of Trinidad, in the Gulf of Paria, in the Island of Antigua, and in British Guiana, within 50 miles of Georgetown. The exact location and bounds of the bases, the necessary seaward, coast and anti-aircraft defences, the location of sufficient military garrisons, stores and other necessary auxiliary facilities are to be determined by common agreement. The American destroyers to be handed over as requested are, it is stated, of the 1190-ton flush deck type and are generally contemporaries of the "V" and "W" classes of the Royal Navy, of which some fifty were in service at the outbreak of war. Their original armament comprises four 4in. and one 3in. A.A. guns and twelve torpedo tubes. It was announced by the United States Navy Department on Tuesday afternoon, September 3rd, that eight of the destroyers to be released to the Royal Navy will be ready at Boston on Friday (to-day), September 6th. They will, it is further announced, be sent to Canadian ports with their present crews and will be there taken over by British crews. Other destroyers of the fifty are to be released and sent over as requested.

Railways and the Black-Out

IT is pointed out by the railway authorities that the intensification of air activity and machine gun attacks which German raiders have made on passenger trains calls for increased co-operation by the travelling public, if adequate lighting is to be maintained in trains during the coming winter months. The work of adapting lighting systems in the carriages of our main line and London Transport systems has been carried out steadily and it is now reported that 400,000 lights have been fitted in 220,000 compartments. That work represents the whole of the carriages in regular service, and as vehicles come in for overhaul the lighting systems are being adapted to war-time needs. The question of whether railway colour light signals may not possibly help enemy pilots in an air raid has recently been raised, but that matter has been given the closest attention by the Government Departments concerned, including the Air Ministry. It is stated that the alterations which were made to some signal lights shortly after the outbreak of war are considered to have rendered railway signals sufficiently inconspicuous from the air. The railway companies have also carried out extensive work at their marshalling yards in order to provide necessary working light, but at the same time a complete black-out in case of an air raid warning. Several hundreds of marshalling yards have been re-wired and furnished with main lighting switches, which are kept manned so that they can be switched off in an air raid. The subject of flashes from electric trains is a matter that has received the careful attention of the Ministry of Transport and the Air Ministry and Ministry of Home Security. It has been decided to maintain the operation of electric trains during air raids, but they will run at a lower speed, which will reduce the possibility of flashing. Another item has been the reduced lighting at railway stations and the use of whitewash on the edges of platforms, steps, pillars, kiosks and barriers. The amount of whitewash so employed has been estimated to cover some 6,600,000 yards.

Subaqueous Tunnel at Mobile, Alabama

MOBILE, a city at the mouth of the Mobile River, Alabama, is putting the finishing touches on an under-river tunnel for motor traffic. It is situated on the trace of the old Spanish trail which was blazed some hundreds of years ago by the Spanish *conquistadors* in their long trek from the east coast of Florida to the southern shores of California.

The old Spanish trail, in its present-day development of Route 90, is reputedly the heaviest travelled highway of the Southern States, and for much of its course it hugs the shore line of the Gulf of Mexico. Its use has increased greatly in recent years, and this movement east and west has been unavoidably right through the busiest sections of the city, entailing, incidentally, passage through a number of winding and narrow streets that have led to congestion and inconvenience to transients and residents at peak periods. The situation has been intensified by traffic entering and leaving Alabama's only seaport over a number of other much-used highways that converge upon Mobile and serve a far-flung hinterland.

Mobile is situated on the west bank and at the mouth of the river, and is at the head of Mobile bay, 30 miles inland from the open waters of the Gulf of Mexico. According to the 1940 Census, Mobile has a population of 78,000. Well upstream from the water front contiguous to the business section of the city are situated the Alabama State Docks, that are used by ocean-going vessels that make Mobile a regular or intermittent port of call; and that nothing should hamper those vessels in entering and leaving the port the first crossing for vehicles is a lift bridge about 3 miles upstream. This crossing entails a narrow looped detour that has a length of fully 7½ miles.

The Bankhead tunnel, as the river underpass is named, connects Government Street in Mobile with Blakely island, just across the river, and a short length of new highway on the island adjoins the Cochrane Causeway, thus completely by-passing the 7½-mile loop. The decision to build a tunnel instead of a high fixed span was a wise one. A span that would have given sufficient under-clearance for shipping would have required long approach structures; and in Mobile, because of the low and generally flat terrain, that would have been very costly and would have unavoidably interfered with traffic on a number of cross streets. The depth of the tunnel below low water and the length available for the approach in Mobile necessitated a maximum slope of 6 per cent. for a distance of 790ft. at the western end.

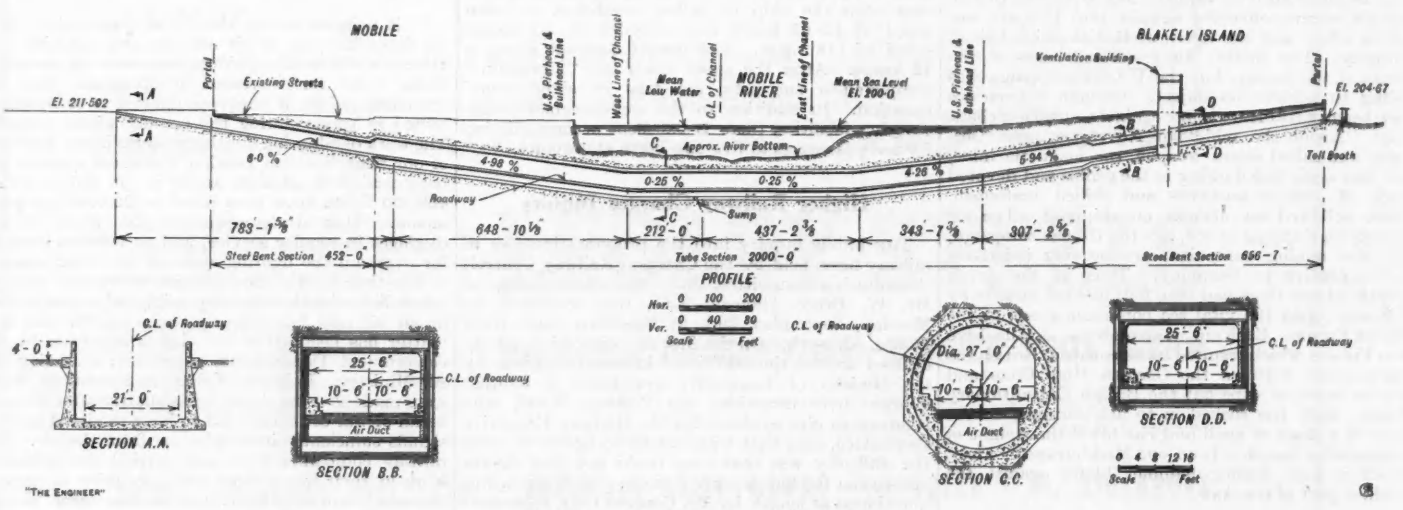
Between the extreme limits of the tunnel the underpass has a length of substantially 3388·5ft.—see accompanying drawing. Starting at the Mobile end, there is an open-cut ramp 280ft. long leading down to the west portal. The ramp adjoins a rectangular cut-and-cover section, which is of steel-bent construction and has a length of 452ft. The steel bent section is connected by a short transition section with the first of the cylindrical steel sections which under-run the river. This part of the tunnel has a total length of 2000ft. and is made up of seven interconnected unit sections, five of which are each 298ft. long and two are each 255ft. long, the two shorter sections being at the ends of the tubular structure. On Blakely island there is another transition section which connects the eastern end of the tube section with a rectangular steel bent section, 656·5ft. long, which rises up to the ground level on the island. Here the roadway of the tunnel meets a short length of new roadway that leads directly to the western end of the Cochrane Causeway at the eastern waterside of Blakely island. For about the last 963ft. of the climb out of the tunnel from the eastern section the roadway has a gradient of 5·94 per cent. The mid-length section, under the river, for 649ft. is virtually level, the adjoining sections, east and west, respectively, having slopes of 4·26 and 4·98 per cent.

The War Department required that the top of the tunnel should at no point under the river be less than 45ft. below low water level in the main channel; and the authorities of Mobile insisted that the tunnel should not interfere with traffic on crossing streets or necessitate any change of grading in those streets. The open-cut ramp approach, therefore, has its lip just short of a crossing street and extends slightly less than four blocks inshore from the water front of the community. These restrictions are responsible for the roadway gradients on the Mobile side of the river; and the desire to save money and to bring the tunnel up to the surface at the east portal without unnecessary lengthening of the structure accounts for the slope adopted at that section of the undertaking.

The ground formation on both shores and in the bed of the river consists mainly of coarse sand. The river trench was excavated to a depth of 65ft. by suction dredge, and then the remainder of that work was carried down to the ultimate depth of 81ft. by bucket dredging. On the Mobile side, part of the work was done in a steel sheeted cofferdam, which was excavated to a depth of fully 75ft. at the low point, and a section of that open cut to a depth of 45ft. was kept free of seepage by a wide use of well points. The fact that the ground was coarse sand and that 45ft. was considerably below ground water level and near the river, indicates how effective the well points were.

The seven tubular sections of the under-river part of the tunnel, which were sunk into position, were built at the nearby yard of the Alabama Dry-dock and Shipbuilding Company, of Mobile, and each section was put together throughout by welding. Each of these sections is made up of an inner cylindrical steel tube, having a diameter of 30ft., and built of plating, ⅜in. in thickness. Surrounding that inner tube there is an outer tube of octagonal cross section that has a minimum diameter of 34ft. The two tubes are tied together by steel ribs or diaphragms spaced longitudinally 12ft. apart on centres. The outer skin or shell is of ½in. plating, and all sides are so plated except the top face of the octagon, which was left uncovered to facilitate the pouring of the enveloping concrete that fills all the spaces between the two shells. The inner cylindrical tube has an internal lining of reinforced concrete that has a general thickness of not less than 18in.—the reinforcing consisting of annular hoops and longitudinal rods tied together. Above the springing line one side wall is thickened to house the asbestos cement pipes that serve as ducts for telephone circuits, light and power cables, &c., and an extension of the other side wall provides a narrow sidewalk for policing service. Between the two flanking cast iron curbs the roadway has a width of 21ft., and is designed for two traffic lanes, one for eastbound and the other for westbound service. The roadway slab is 16in. in thickness and heavily reinforced with I beams, to which are secured longi-

MOBILE APPROACH UNDER CONSTRUCTION



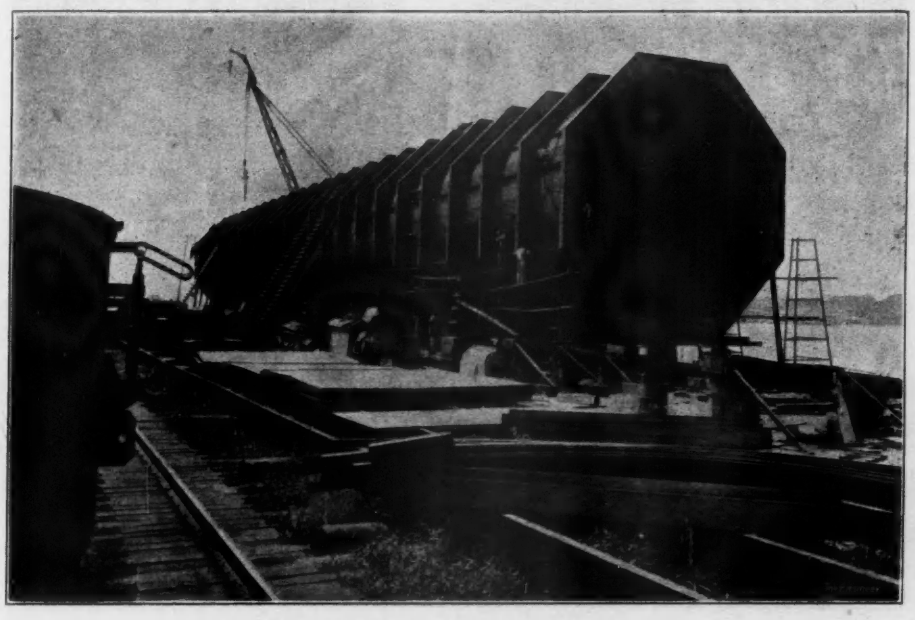
PROFILE AND SECTIONS OF TUNNEL

tudinal rods. The top of the roadway is belt finished to produce an approved form of concrete pavement. The object of the rather massive roadway slab is to assure a structure that will obviate the more usual types of replaceable pavement.

The Bankhead tunnel differs from other American vehicular tunnels for subaqueous service in that ventilation is stimulated only by suction blowers intended primarily to remove vitiated air from the low mid-river section of the structure. No fresh air is discharged into the tunnel by means of power-driven fans. Under the roadway slab, for 200ft. each side of the mid-length of the tunnel, there is a large exhaust air duct from which air flues lead up on both sides with openings at the roadway level. This duct is connected with the single ventilation building which is situated on Blakely island—an air duct under the roadway of the eastern box section of the tunnel forming an intermediate conduit. In the ventilation building there are three suction fans, driven by 350 H.P. motors. These three fans are capable of exhausting 274,000 cubic feet of air per minute. Normally, only two of the fans will be operating. The idea is that by drawing off the vitiated air in the low part of the tunnel, an inflow of fresh air downward from the portals will be promoted in ample volume to keep the carbon-monoxide content within the limits of 4 parts of gas in 10,000 parts of air. Experiments made by the U.S. Bureau of Mines have indicated that hot carbon monoxide when cooled tends to settle instead of to rise, and the fresh air entering the tunnel from the portals is counted upon to cool the exhaust gases sufficiently to promote their descent so that the suction movement caused by the exhaust fan will have sufficient force to withdraw the tainted air from the tunnel. How effective this arrangement will be at different seasons and under changing atmospheric conditions in the neighbourhood of Mobile has yet to be discovered. The present arrangements have simplified the ventilation plant and have kept the outlays low for that part of the undertaking.

Ground was broken for the tunnel in Government Street, Mobile, near the end of December, 1938, but construction work was not started until July, 1939. Funds for the project were obtained in the form of a grant of 1,500,000 dollars from the Public Works Administration, rounded out to 4,000,000 dollars by a loan of 2,500,000 dollars from the Reconstruction Finance Corporation—both organisations being Government bodies. The loan is secured by 30-year revenue bonds issued by the City of Mobile, and the tolls, which will be varied as traffic grows, are counted upon to cover the 4 per cent. interest charge and to pay off the debt within an estimated three decades. The principal contract has been held by the Arundel Corporation, of Baltimore, Md., under whom various parts of the task have been awarded to different qualified concerns.

The Alabama Drydock and Shipbuilding Company constructed the seven under-river tubular sections in succession, and as each reached a suitable stage it was launched sidewise into the Mobile River and towed about half a mile to a slip on Blakely island, where the placing of most of the concrete within the inner tube and between the inner and outer shells was done. When ready for launching, each end of each tube was sealed by a temporary bulkhead, and before the section was put overboard the inner tube was subjected to an internal air pressure of 5 lb. per square inch. Before that pressure was developed all external joints of the welded structure were coated with soapy water, and any leaks betrayed themselves by blowing bubbles. Immediately after launching each tube was dry-docked, and while on the keel blocks concrete was pumped into the bottom intracostal spaces up to the turn of the bilge. That

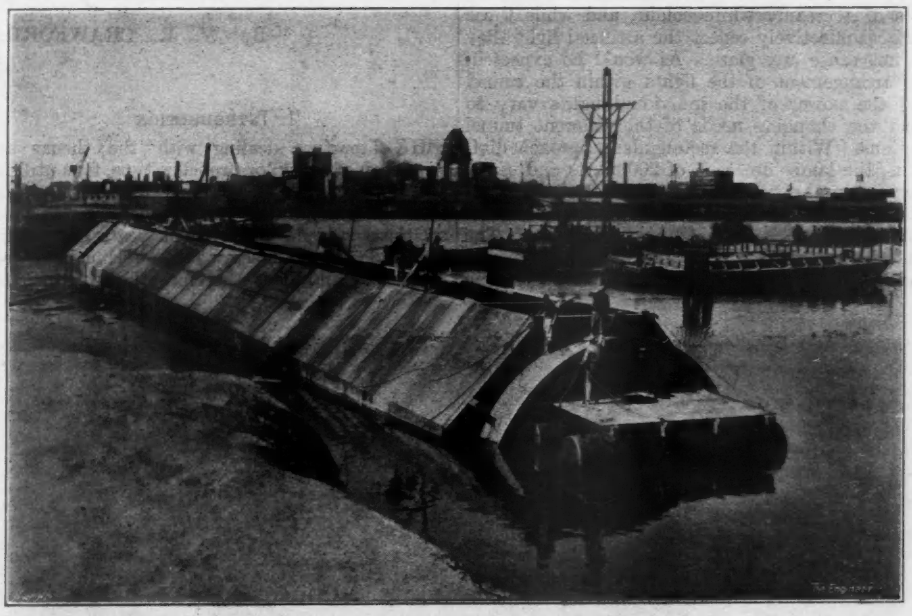


TUBULAR SECTION UNDER CONSTRUCTION

deadweight gave the section suitable stability when refloated and made for easier handling when shifting the section from the shipyard to the slip on Blakely island. At Blakely island access to the completely closed inner tube was afforded by cutting hatchways at several points along the centre line of the top plating of the cylindrical tube. Those hatchways, each about 18in. by 26in. square, were afterwards sealed with welded patch plates when the work at Blakely island was finished. While at the island the 18in. concrete lining and the other concrete features of the inner tube were poured after the reinforcing steel was put in place. The transverse 10in. I-beams of 25·4 lb. section in the roadway slab were set 24in. apart on centres. Those beams rested on 8in. I-beams, arranged longitudinally, where the air flues curve under the roadway slab to connect with the exhaust air duct. Steel collapsible forms were used in pouring the concrete lining of the inner tube and the supporting wings and slab of the roadway. The concrete was poured in three lifts, with ⅝in. longitudinal and circumferential reinforcing rods. The concrete was pumped into place from a floating plant tied alongside. All but the crown section of the concrete between the inner and outer shells was placed before a section was moved from the slip. By that time the section had settled deeply in the water and retained a reserve of buoyancy of but 10 tons when ready to be moved from the island and stationed over its assigned position for sinking into the trench dredged in the river bottom.

The concreting of the crown section through the open top of the octagonal shell served to destroy all reserve of buoyancy and to give the section sufficient dead weight to carry it down into the trench, but the section was not allowed so to drop directly to its resting place. Instead, each end of each section was sustained by a sling pendant from chain hoists secured to a gallows frame erected transvervsely above the section. The cross member was formed of two deep I-beams sustained at each end by a cluster of six 14in. H section steel piles—three vertical and three driven on a batter. The two chain blocks that hung from the I-beams were each of 15-ton capacity. It was thus possible, when the section acquired negative buoyancy, to sustain it in the slings and to lower it deliberately into the trench. Incidentally, the pile clusters of the gallows frames made it possible to hold the section in perfect alignment against the sweep of tidal currents. The trench was dredged about 2ft. deeper than the prescribed final elevation of the bottom line of the river sections of the tunnel, and when a section was lowered to within a few inches of that line a good bedding of backfill was placed in the trench beneath the section, the difference of the few inches mentioned representing the ultimate settlement that would occur when the full weight of the completed section caused compaction of the fill. The concluding concrete was poured in the section by tremie after the section was suspended under water. The first of the sections to be sunk was placed at the eastern end of the trench, and the succeeding sections followed as the tube was lengthened westward to the Mobile shore. The backfilling to the top of the trench followed the landing of a section and the release of the slings. The minimum cover is about 10ft. between the top of the tunnel and the level of the river bed.

The first section was very carefully aligned by survey stations on each side of the river. The alignment of a succeeding section with the one previously planted was effected by the engagement of two projecting pins, one on each side near the horizontal axis, in correspondingly placed slotted brackets on the contacting end of the adjoining section. The two ends were then brought snugly together by a type of turnbuckle, familiarly known as "steamboat ratchet." Six of these turnbuckles, connected at as many points by divers to lugs on the opposing tubes, were then worked by the divers to draw the tubes together until an annular collar on one tube was pulled against a gasket of heavy rubber and rubberised cord set in a circular recess in the opposing end of the other section. With this bond made, enveloping curved form plates, slipped into recesses provided for the purpose, then served to confine the tremie-poured concrete which made a collar 10ft. wide around the joint. The final union between adjoining tube



CONCRETING TUBULAR SECTION AT BLAKELY ISLAND

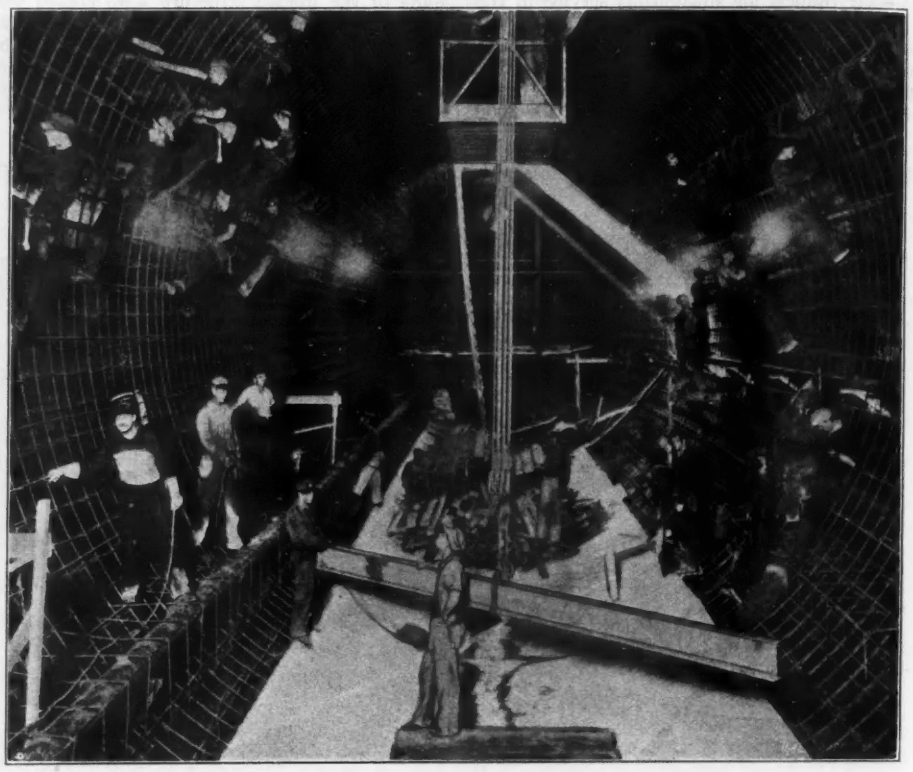
ends consists of a completely welded annular interior channel which provides a water-tight seal as well. It will be understood that this work was done in the dry and from within the tubes when the temporary bulkheads at each end of each tubular section were burned away to give access. The removal of the bulkheads was done progressively, working from the shore ends when that approach became possible through unwatered cofferdams on the Mobile and the Blakely island ends of the work.

Although the eastern portal rises to the ground level, still that approach is entirely covered by backfill. This has been done to protect the structure from any damage from the hurricanes that intermittently sweep inland from the Gulf of Mexico and raise the level of Mobile Bay as much as 11ft. above normal high water. Waves are driven by storm winds up on to the eastern side of Blakely island and to a level about 6ft. above the elevation of the roadway at the eastern portal of the tunnel. Therefore, the Bankhead tunnel is equipped at that point with hurricane gates that are so hung from a trolley on the two sides of the portal that they can be run into position across the portal and secured together so as to make a central tight joint.

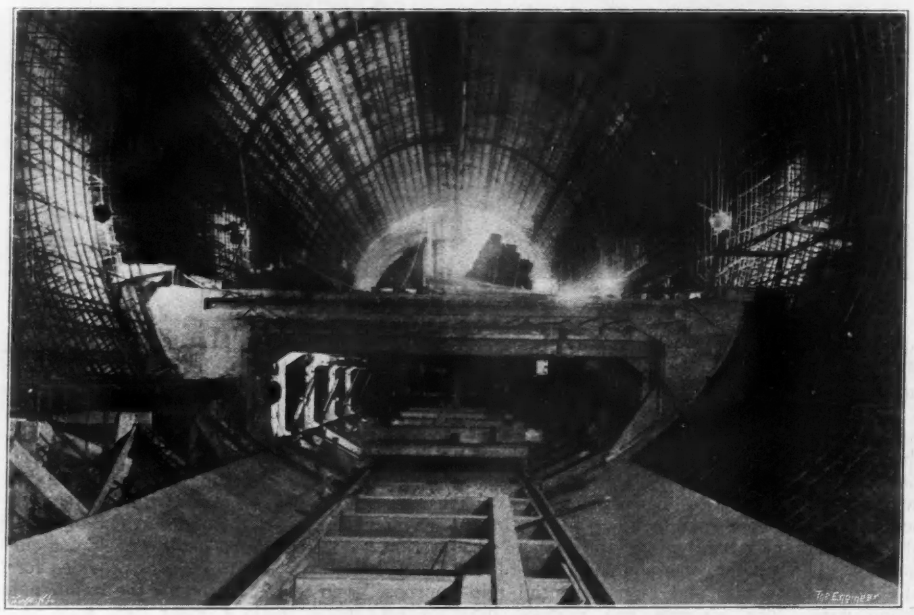
Mobile is in a region that is subject to very heavy rainfalls at some seasons, and because of the open-cut approach ramp at the western end of the tunnel the structure has unusual facilities for dealing with water that may enter it during the downpour or may get into the tunnel by leakage through the hurricane gates. Inside the tunnel there are special sumps that are so proportioned that they can hold rain that may run into the tunnel during a period of three-quarters of an hour even when the precipitation is at the known maximum of 4in. an hour. The sumps are intended to meet an emergency in which the pumping plant may be temporarily out of service. Power for operating the pumps and for driving the ventilating fans, and current for lighting the interior of the tunnel will normally be supplied by plants at the two ends of the tunnel. However, should neither of these plants be able to furnish electricity, the emergency may be met by a generating set, gas engine driven, installed in the ventilating building. That standby plant will be able to provide enough current for the lights and the pumps and to drive the suction fans at a rate that will assure a reasonable minimum of ventilation. Again, should this emergency plant fail, then storage batteries will be relied upon for current for lighting purposes.

The side walls and ceiling of the various divisions of the Bankhead tunnel are finished with ceramic tiles of a creamy white colour, and while those surfaces effectively reflect the artificial light they do not cause any glare. As would be expected, the arrangement of the lights within the tunnel and the power of the individual lights vary to meet the changing needs of the different tunnel sections. Within the rectangular approach divisions, the lamps are each of 200 watts and set in recesses in the side walls 30ft. apart. Adjacent to the portals there will be ceiling lights along the centre line each of 750-watt capacity. The first of these lights will be 20ft. in from the portal and at 5ft. intervals for 60ft., and for the succeeding 50ft. the lights will be placed at 10ft. intervals. The purpose of this arrangement is to aid the eyes of a driver when making the more or less trying visual transition from broad daylight to the relatively much dimmer illumination of the tunnel. These ceiling lights will not be in service after nightfall. Within the under-river sections of the tunnel illumination will be by ceiling lights arranged on 50ft. centres and each of 300-watt capacity.

The engineering and financial consultants for the undertaking have been Messrs. Wilberding and Palmer, Inc., of Washington, D.C., and Mobile, and Mr. Wayne F. Palmer, vice-president and treasurer of that concern, has been directly in charge of the engineering and contract work for the municipality. The chief engineer has been R. F. Schaefer, and the construction engineer has been L. A. Ludwig. For the Public Works Administration the project engineer has been E. H. Hopson. The Arundel Corporation has been represented on the job by E. H. Burwell, as supervising construction engineer.



ERECTION OF REINFORCING STEELWORK FOR SIDE WALLS



FORMATION OF ROADWAY SLAB

Theory of Screw Fans

By W. R. CRAWFORD, D.Sc., Ph.D., Whit. Sen. Sch.

No. I

1. INTRODUCTION

THE literature dealing with the theory and design of screw, or propeller-type, fans utilising aerofoil blade sections is very limited in extent, although there exists a demand for information on these subjects. Of recent years only a few papers dealing with screw fan problems have been published, and it is therefore thought that the present paper may be acceptable. It attempts to present concisely the aerodynamic theory of cased fans (fans working in a casing against pressure greater than atmospheric), and proceeds to indicate a method by which this theory may be applied to the practical problems of blade design.

The fundamentals of the theory given are not new and are based on the aerofoil element theory and the vortex theory of propulsive airscrews. In the method of reducing the general equations of thrust and torque, however, the present paper departs from normal procedure, and the solutions obtained are in such forms that they may be applied directly to blade design, and the normal methods of successive approximation are thus eliminated.

2. AIRSCREW THEORY IN RELATION TO THE SCREW FAN

(i) *General.*—All modern airscrew theories are based on the assumption that each element of the blade of an airscrew may be regarded as an element of a uniform aerofoil in two-dimensional motion, due account being taken of the disturbance of the air flow in its neighbourhood. The term "interference flow" is used to denote the velocity field of the system of trailing vortices which affects the aerodynamic behaviour of the blade elements. The flow immediately in front of the screw is referred to as the "inflow," and that immediately behind as the "outflow." The term "wake" is applied to the final steadily flowing slipstream.

An important aspect of airscrew theory is the determination of the ratio of the induced air velocity in the airscrew wake to that in the plane of the screw. This ratio, which depends largely upon the conditions under which the screw is operating, is in general difficult to estimate with any degree of accuracy. In the case of a screw

fan which rotates in a fairing of almost equal diameter, and which discharges into a rigid tube, it is possible for the ratio of induced velocities to approach closely to unity. To ensure this condition the suction fairing must be so shaped that the air feeds axially into the fan, and the cross section of the discharge tube must be such that its area remains constant and equal to the area of the fan disc. A further necessary condition is that of minimum blade tip leakage.

The most common slipstream pressure conditions for this class of fan are shown in Fig. 1. Fig. 1 *a* represents a fan the duty of which is to deliver a quantity of air against a resistance situated downstream. At an infinite distance from the fan on the suction side the air has zero velocity and atmospheric pressure. In front of the fan disc the air has been accelerated to a velocity u, and by virtue of Bernoulli's equation the static pressure at this point must be $(p_a-\frac{1}{2}\rho u^2)$. If the resistance against which the fan is blowing is such that it causes a pressure drop p_r, then in order that the fan may discharge into the atmosphere it must create a total head $(p_r+\frac{1}{2}\rho u^2)$.

If the resistance is situated upstream then the slipstream conditions are given by Fig. 1 *b*. In this case there is an additional pressure drop in front of the fan, corresponding to the drop across the resistance, but the duty of the fan remains as before ; it must generate a total pressure of $(p_r+\frac{1}{2}\rho u^2)$.

Fig. 1 *c* shows the conditions prevailing in the

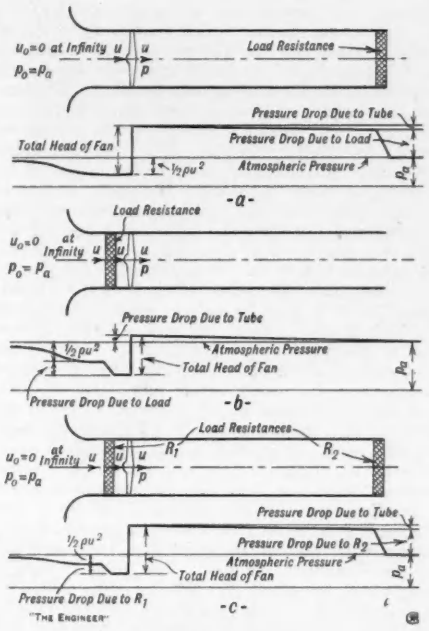


FIG. 1

slipstream when there is resistance to flow, both before and behind the fan.

In all practical examples of a fan working in a tube, the resistance of the walls of the tube will give rise to additional pressure drops before and behind the fan. This has been indicated in Fig. 1.

(ii) *Thrust and Torque and the Momentum of the Slipstream.*—In passing through the fan disc a fluid element receives an increment of pressure p^1 and has imparted to it an angular velocity ω. The axial velocity remains unchanged.

The total difference of pressure on the two sides of the disc measures the thrust of the fan and the angular momentum imparted to the air is a measure of the fan torque. We may therefore write, referring to an element at radius r,

$$\left.\begin{aligned}\frac{d\,T}{d\,r}&=2\,\pi\,p^1 r\\ \frac{d\,Q}{d\,r}&=2\,\pi\,\rho\,u\,\omega\,r^3\end{aligned}\right\} \quad . \quad . \quad . \quad (1)$$

where $d\,T$ and $d\,Q$ are the elements of thrust and torque respectively.

The air flow may be assumed to be irrotational, except for the discontinuity in passing through the fan disc, and hence Bernoulli's equation may be applied to the motion before and behind the fan.

Thus,

$$p+\tfrac{1}{2}\rho\,u^2=p_a,$$

before the fan, and

$$p^1+p+\tfrac{1}{2}\rho\,(u^2+\omega^2r^2)=p_1+\tfrac{1}{2}\rho\,(u_1^2+\omega_1^2r_1^2),$$

behind the fan. The suffix, $_1$, refers to the wake conditions.

The above equations give

$$p^1=(p_1-p_a)+\tfrac{1}{2}\rho\,u_1^2+\tfrac{1}{2}\rho\,(\omega_1^2r_1^2-\omega^2r^2).$$

In the special case under consideration there is no contraction of the slipstream and hence, by virtue of the equations expressing the continuity of the flow,

$$u_1=u,$$

and

$$\omega_1=\omega,$$

so that the pressure rise is given by

$$p^1=(p_1-p_a)+\tfrac{1}{2}\rho\,u^2 \quad . \quad . \quad . \quad (2)$$

If M_u and M_ω denote respectively the linear momentum and angular momentum of the slipstream, then

$$\frac{d\,(M_u)}{d\,t}=\int_0^{R_1}2\,\pi\,\rho\,u_1^2r_1\,d\,r_1=\int_0^{R}2\,\pi\,\rho\,u^2r\,d\,r\ ,$$

$$\frac{d\,(M_\omega)}{d\,t}=\int_0^{R_1}2\,\pi\,\rho\,u_1\omega_1r_1^3\,d\,r_1=\int_0^{R}2\,\pi\,\rho\,u\,\omega\,r^3\,d\,r\ ,$$

and it is immediately seen that the torque, Q, is equal to the rate of increase of angular momentum of the fluid.

Combining equation (2) with the expression for the element of thrust given by (1), we have

$$\frac{d\,T}{d\,r}=\pi\,\rho\,u^2r+2\,\pi\,r\,(p_1-p_a),$$

from which it is evident that the thrust is not equal to the rate of increase of linear momentum.

The work done by the element of thrust is $u\,d\,T$, and this is clearly all useful work, since the element of thrust is due to the sum of the static and dynamic heads.

(iii) *Aerofoil Element Theory.*—It has been shown, both theoretically[1] and by experiment,[2] that the action of a blade element at a given radius is independent of any other element of the blade, and hence we may consider an element of a fan blade rotating with angular velocity Ω, the radius of the element from the axis of rotation being denoted by r.

This element is subject to an interference flow of u axially, and $\Omega\,a^1$ in rotation, where a^1 is the rotational interference factor. It follows that the velocity diagram for the blade element is as shown in Fig. 2. The tangential and axial velocities of the blade element, relative to the air, are $(1-a^1)\,\Omega\,r$ and u, respectively, so that the air angle

$$\phi=\tan^{-1}\frac{u}{(1-a^1)\,\Omega\,r}.$$

The resultant blade velocity is

$$W=\sqrt{u^2+(1-a^1)^2\,\Omega^2\,r^2}\ ,$$

and the angle of incidence $\alpha=\theta-\phi$, where θ is the blade angle. The lift force appropriate to the aerofoil section and angle of incidence acts in a direction normal to that of W, and the corresponding drag force acts in the direction of W, but is of opposite sense.

These forces may each be resolved into two components, one in the direction of the fan axis, and the other tangential to the fan disc annulus at radius r. The axial components, which determine the thrust on the blade element, are expressed as

$$\lambda_1=k_L\cos\phi-k_D\sin\phi \quad . \quad . \quad . \quad (3)$$

The tangential components controlling the torque are similarly given by

$$\lambda_2=k_L\sin\phi+k_D\cos\phi \quad . \quad . \quad . \quad (4)$$

The lift and drag coefficients k_L and k_D are those appropriate to the aerofoil section in two-dimensional motion, *i.e.*, they must correspond to infinite aspect ratio.[3] Glauert has stated that in general it is sufficiently accurate to apply the corrections for elliptic loading of the blade and the corrected aerofoil characteristics are then given by

$$\alpha=\alpha^1-\frac{A}{2\,\pi\,S^2}\cdot k_L\ ,$$

$$k_D=k^1{}_D-\frac{A}{2\,\pi\,S^2}\cdot k_L^2\ ,$$

where α and k_D refer to infinite aspect ratio, α^1 and $k_D{}^1$ to a finite aerofoil of area A and semi-span S, for a definite value of k_L, α being in circular measure.

It follows from equations (3) and (4) that for all the blade elements of chord c at radius r, of a fan having B blades, the elements of thrust and torque are respectively,

$$d\ T=\lambda_1\,\rho\,W^2\,B\,c\,.\,d\,r,$$

and

$$d\ Q=\lambda_2\,\rho\,W^2\,B\,c\,r\,d\,r.$$

In dealing with design problems it will, in general, be more convenient to consider Ω than W, and so we may substitute for W the expression $(1-a^1)\,\Omega\,r\,.\sec\phi$. Also, it is usual to substitute for c a non-dimensional factor defined by the equation

$$\sigma=\frac{B\,c}{2\,\pi\,r}.$$

This factor, known as the "solidity" of the blade elements, represents the ratio of the area of the blade elements to the area of the annulus at radius r.

Effecting these substitutions, the elements of thrust and torque are finally expressed as

$$\frac{d\,T}{d\,r}=2\,\pi\,\lambda_1\,\rho\,\sigma\,(1-a^1)^2\,\Omega^2\,r^3\sec^2\phi \quad . \quad (5)$$

$$\frac{d\,Q}{d\,r}=2\,\pi\,\lambda_2\,\rho\,\sigma\,(1-a^1)^2\,\Omega^2\,r^4\sec^2\phi \quad . \quad (6)$$

The element of torque has already been expressed in the form $\frac{d\,Q}{d\,r}=2\,\pi\,\rho\,u\,\omega\,r^3$, where ω is the rotational velocity in the outflow and is given by $\omega=2\,\Omega\,a^1$.[4] Hence $\frac{d\,Q}{d\,r}=4\,\pi\,\rho\,u\,\Omega\,a^1\,r^3$, and so equating the alternative expressions for the element of torque,

$$4\,\pi\,\rho\,u\,\Omega\,a^1\,r^3=2\,\pi\,\rho\,\lambda_2\,\sigma\,(1-a^1)^2\sec^2\phi\ .\ r^4.$$

Since $u=(1-a^1)\,\Omega\,r\tan\phi$, it follows that

$$(1-a^1)=\frac{\sin 2\,\phi}{\sin 2\,\phi+\lambda_2\,\sigma} \quad . \quad . \quad . \quad . \quad (7)$$

Equation (7) determines the rotational interference factor in terms of the attitude, dimensions, and aerodynamic characteristics of the blade element, and it may be shown that equations (5), (6), and (7) are sufficient to solve completely

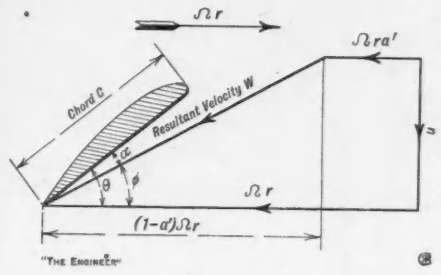


FIG. 2

the problems of blade design for screw fans operating in a casing.

(iv) *Efficiency of a Blade Element.*—The energy supplied to a blade element in unit time is $\Omega\,d\,Q$, and this energy is distributed in three parts, viz.:—

(*a*) The work done by the thrust,
(*b*) The rotational energy of the slipstream,
(*c*) The energy absorbed by drag in moving the blade element relative to the air.

The useful work is that done by the thrust and is given by $u\,.\,d\,T$, for unit time, and hence the efficiency of the blade element is

$$\eta_e=\frac{u\,.\,d\,T}{\Omega\,.\,d\,Q}.$$

Since $d\,T=\lambda_1\,B\,c\,\rho\,W^2d\,r$, and $d\,Q=\lambda_2 B\,c\,\rho\,W^2r\,d\,r$ the efficiency may be expressed as

$$\eta_e=\frac{\lambda_1}{\lambda_2}\cdot\frac{u}{\Omega\,r} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

If, as is sometimes the case in fan work, the efficiency based on static head only is required, it may be obtained from that given above by reducing it in the ratio $\frac{\text{static head}}{\text{total head}}$.

3. Relation of Blade Shape to Thrust Distribution

(i) *General.*—An examination of the simple momentum theory of propulsive airscrews indicates that ideal conditions are attained when the thrust is uniformly distributed over the airscrew disc. The objective is to make the wake velocity uniform and the motion parallel to the axis of the screw. Earlier writers have assumed that this condition of uniform thrust distribution is desirable in determining the most appropriate shape for fan blades, and Poole[5] has made use of an expression for blade width derived at an earlier date by Riach.[6] Riach's work referred only to propulsive airscrews, and although an allowance was made for drag on

[1] H. Glauert, "Elements of Aerofoil and Airscrew Theory."

[2] Lock, Bateman and Townend, "Experiments to verify the independence of the elements of an airscrew blade." R. and M. 953, 1924.

[3] This has been established by Glauert, "An Aerodynamic Theory of the Airscrew, R. and M. 786, 1922.

[4] For proof of this see "An Aerodynamic Theory of the Airscrew," *loc. cit.*

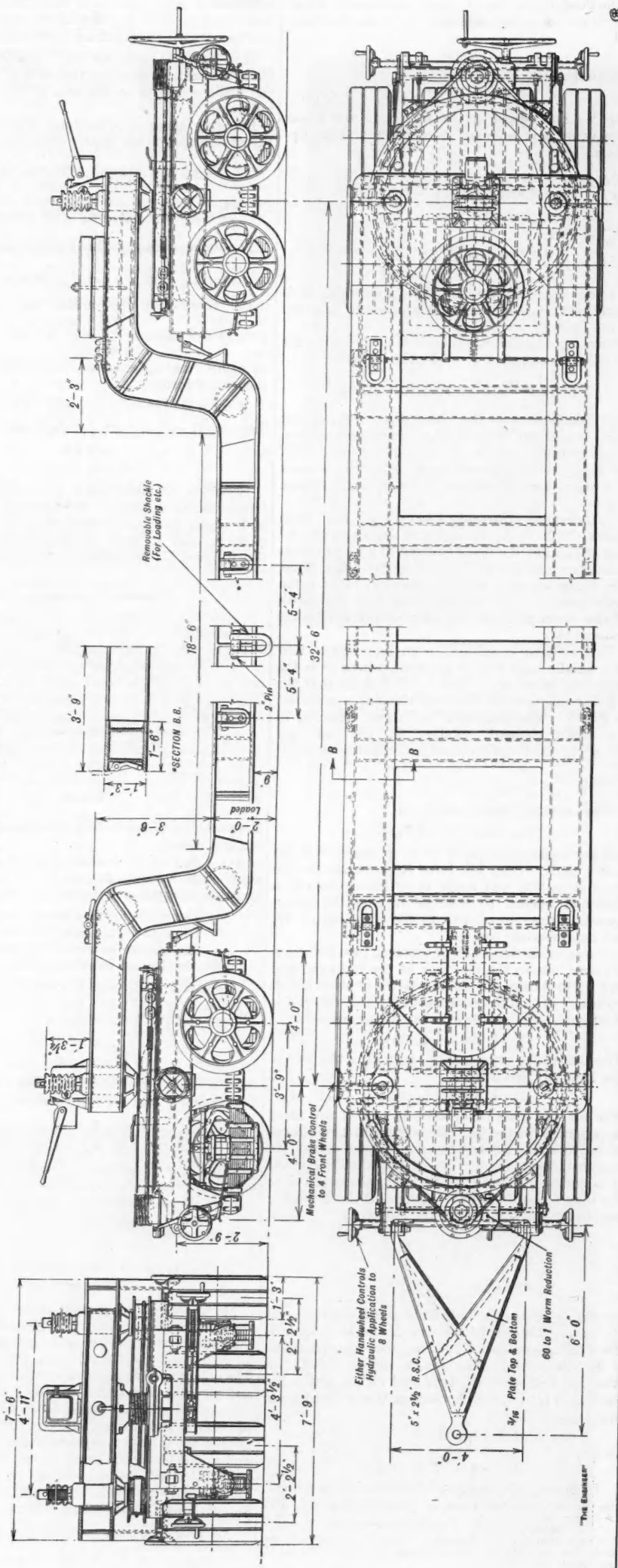
[5] R. Poole, "Proc." Inst. C. Eng. Selected Eng. Papers No. 178 (1935).

[6] M. A. S. Riach, "Airscrews," London, 1916.

DOUBLE-CRANKED TRAILER FOR 80-TON LOADS

CRANES (DEREHAM), LTD., MANUFACTURERS

(For description see opposite page)



the blades, no account was taken of the rotational interference velocity.

Tietjens[7], in a paper read before the Am. Soc. Mech. Eng., has stated that the assumption of constant pressure rise over the fan disc necessitates high rotational velocities near the hub, with consequent high losses due to rotation of the slipstream. He suggests that in order to reduce these rotational losses, it is advisable to distribute the thrust so that $\frac{d\,T}{d\,r}$ decreases more rapidly with the radius than is the case with uniform thrust distribution.

It is the author's opinion that the most desirable form of thrust distribution for general fan work is that given by the assumption that the "useful head" is uniformly distributed over the fan disc. In the present instance the "useful head" is equal to the total head, although this is not the case for all types of screw fan.

It is on the basis of uniform distribution of total head, with certain restrictions and modifications, that the method of applying the general equations to blade design is developed.

(To be continued)

Sixty Years Ago

Ingot Iron

We have on previous occasions mentioned in this note the strong feeling which many engineers expressed against steel as a structural material when it was first introduced and for many years afterwards. Undoubtedly the earlier products of the Bessemer converter gave good reason for distrusting them as substitutes for wrought iron. Subsequent improvements, even the introduction of the Siemens-Martin open-hearth process and the development of the Thomas and Gilchrist basic process, failed to remove the widespread dislike of steel among engineers, shipbuilders, and boilermakers. The strength of that dislike was expressed in a leading article in our issue of September 3rd, 1880. We argued that the product of the Bessemer converter or Siemens open-hearth furnace ought not to be called "steel," but "ingot iron." The word "steel" should, we said, be confined to the product of the crucible or cementing furnace which always possessed characteristics which distinguished it clearly from any form of iron. Bessemer or Siemens metal, however, very closely resembled iron made in a puddling furnace and ought therefore to be designated in an appropriate way. Nevertheless, although there was a close resemblance between "ingot iron" and the iron such as Lowmoor or Bowling, with which engineers had long been familiar, it was certain that there were certain characteristics with respect to which the two classes of material were very different. The great peculiarity of ingot iron, we wrote, was that for some reason not yet understood, certain impurities affected it more than they did wrought iron. Further, it was very easy to set up in it intense initial strains which never seemed to exist in wrought iron. The manner in which ingot iron failed exerted a malign influence on the future of the metal. To illustrate our argument, we instanced the manufacture of a flanged back plate for a locomotive boiler. Instances had been recorded in which such a plate after being flanged had been put aside for the night. In the morning it was found that the flange had come away from the plate everywhere. If the flange could separate thus from the plate while not in use, what trust could engineers feel in a plate which had been apparently successfully flanged and built into a locomotive boiler? It was true that the flange of a Lowmoor plate would sometimes separate from the plate, but the defect would be manifest from the first, and a crack would be found between the flange and the plate before the metal was cold. The tensile strength of ingot iron was no guide to its quality. A plate of wrought iron with a tensile strength of 25 tons could be bent and contorted in all sorts of ways, and yet would not break. An apparently similar "steel" plate of the same strength would crack a few hours after it had been handled, and might be rendered worthless by punching a couple of holes in it or shearing its edges. Chemically, the two plates would be nearly identical. The dissimilarity of their behaviour must therefore arise from the difference in their method of manufacture. We suggested that one of the causes of the difference might be found in the fact that whereas the fracture of a "steel" plate was either amorphous or crystalline, that of a wrought iron plate was fibrous.

Aircraft Production.—It has been announced that the Minister of Aircraft Production has appointed Mr. A. J. Newman to be Director of Machine Tools, with responsibility for the supply of machine tools to the Ministry of Aircraft Production.

[7] O. G. Tietjens, "Propeller Fans," Trans. Am. Soc. Mech. Eng., Vol. 54 (1932).

An 80-Ton Trailer

IN a half-tone engraving on this page and a drawing opposite we illustrate a double-cranked trailer, for carrying loads up to 80 tons, which was recently delivered to the Central Electricity Board by its manufacturers, Cranes (Dereham), Ltd. Another identical trailer is nearing completion. Each of these vehicles, it will be seen, consists of a double-ended sixteen-wheel trailer, the main frame of which is carried on two bogies. The two bogies are identical and are interchangeable. In the following table the main dimensions are given :—

	Ft.	in.
Overall length, excluding draw-bar	42	2
Overall width	7	9
Laden weight of loading deck	2	0
Maximum height at ends	7	2
Wheelbase : centres of turntables	32	6
Length of main deck	18	6

Points of interest in the design are that arrangements have been made such that as far as possible the wheels will conform to the contour of uneven roads ; that the main frame can be adjusted to ride on three points if it is thought desirable ; that there is a hand steering gear operating on a novel principle ; and that the ground clearance can be increased from 9in. to 15in. when necessary for negotiating a hump-back bridge or similar obstacle.

The main frame is constructed from mild steel plates welded together to form two box section girders. The depth of the frame at the centre of the span is 15in. and the width of each box girder 18in. The flange plates in these girders are 1¼in. thick and ½in. web plates are employed. In order to obtain rigidity of this frame four torsion-resisting cross tubes, 12in. diameter by ½in. thick, are inserted and heavily welded to the web plates of each girder. They are positioned one at the top and one at the bottom of each crank. To ensure that the frame should be straight when loaded an upward camber of ¼in. in the span has been allowed.

It will be seen from the drawing that the main frame is carried from the bogies on king pins. Lateral support is given to the frame through the medium of two 2½in. gudgeon pins resting in self-aligning bushes. The upper surface of the bogie frame is covered by a plate forming a bearing surface, and the turntable consists of a large-diameter channel ring with its flanges turned inwards, stiffened by a longitudinal member fitted on each side. Large crescent-shaped plates welded to the underside of this channel ring form the bearing surface of the turntable. Two 2½in. diameter vertical locking pins are employed to connect the turntable with the bogie when hand steering is not required. Surrounding the turntable there is a second channel section ring forming a cable ring or drum for the hand steering gear. This ring can be made rigid with the turntable or free to rotate at will. The connection is made by means of two horizontal spring-loaded pins, operated by small diameter hand wheels, positioned above the rear portion of the bogie.

Mounted on the front of each bogie is a cable drum, which is operated by a worm and worm wheel with a 60 to 1 reduction. The cable drum is 9in. diameter and has helical grooves to take ⅜in. diameter steel plough cable. The latter is in one piece and is fixed to the channel cable ring on one side by means of clamps. Its other end is attached to the cast steel pin blocks through the medium of a screwed shank, which is arranged to take up slackness of the cable where necessary. One side of the cable proceeds towards the centre of the cast steel cable drum, takes two and a-half turns in a downward direction and then passes into the centre of the drum, emerging through a tangent hole in the top. From this point two and a-half turns are taken in a downward direction before the cable proceeds towards the other side of the turntable cable ring. This peculiar arrangement has been found to be necessary in order that the bogie should not exceed the necessary height.

When the bogie is being steered by draw-bar the two horizontal spring-loaded pins are extracted by turning the hand wheels and the two vertical locking pins, which are positioned just ahead of the king pin, are removed. The bogie is then left completely free to turn in relation to the frame, the cable ring remaining stationary in relation to the bogie. The turntable, of course, is permanently prevented from turning relative to the main frame by the lateral supports. For manual steering of the bogies the two vertical locking pins are removed and the spring-loaded locking pins are permitted to enter the turntable. A 3ft. diameter steering wheel is placed in position on the worm shaft and the bogie can be then manipulated by hand when the trailer is moving on the road. The steering wheel has a steel tubular rim, and a spring-loaded trigger device to retain the boss in position on the worm shaft. A folding handle is provided for optional use when running light. A detachable seat is provided which can be fixed on either bogie so that the steersman may ride when travelling any distance. The seat is so arranged that the man has complete control over one of the brake hand wheels.

Normally the rear bogie is held in position by being connected to the trailer frame. This condition is achieved by the insertion of the two vertical pins previously mentioned. A second draw-bar is provided so that the trailing bogie may also be steered by an additional tractor should it be desirable.

The trailer has independently operated mechanical and hydraulic brakes actuating the same shoes. The brake shoes are 20in. diameter by 4in. wide and operate in cast steel drums. They are of the " Crane " self-centring pattern and have provision for mechanical expansion at one end and for hydraulic expansion at the other. The mechanical expansion is effected by means of the orthodox cam and lever, connected by rods to levers on a cross shaft. Cables from two long upward projecting levers pass round pulleys to a hand wheel and screw centrally placed on the opposite side of each bogie. Each of these hand wheels is independently capable of controlling the mechanical brake application of the end row of wheels. Both may be used together. The hydraulic expansion operates through Lockheed internal wheel cylinders, each having a bore of 2in. Bleeder screws for these cylinders are placed at the back of each brake plate. The wheel cylinders are operated through the medium of flexible tubing by means of two master cylinders positioned at the rear of each bogie. These cylinders are coupled together and in unison supply fluid pressure to all eight wheels. The levers on the master cylinders are coupled together by a compensating device to which pressure is applied through a heavy square section coil spring. This arrangement is intended to confer flexibility on the whole system in order to avoid troubles due to fluctuating temperatures in the fluid. A rod passing through the middle of the coil spring, which in turn presses on a compensating bar, passes along the centre of the bogie to a point from which cables proceed to the brake screws. The latter are situated at the draw-bar end of each bogie. A coupling is also provided proceeding from this centre brake rod to a point at the front end of each bogie, from which a connection can be made to a hauling vehicle. Adjustment to each brake is provided by means of the elongated wing nuts which operate through the medium of the mechanical brake system.

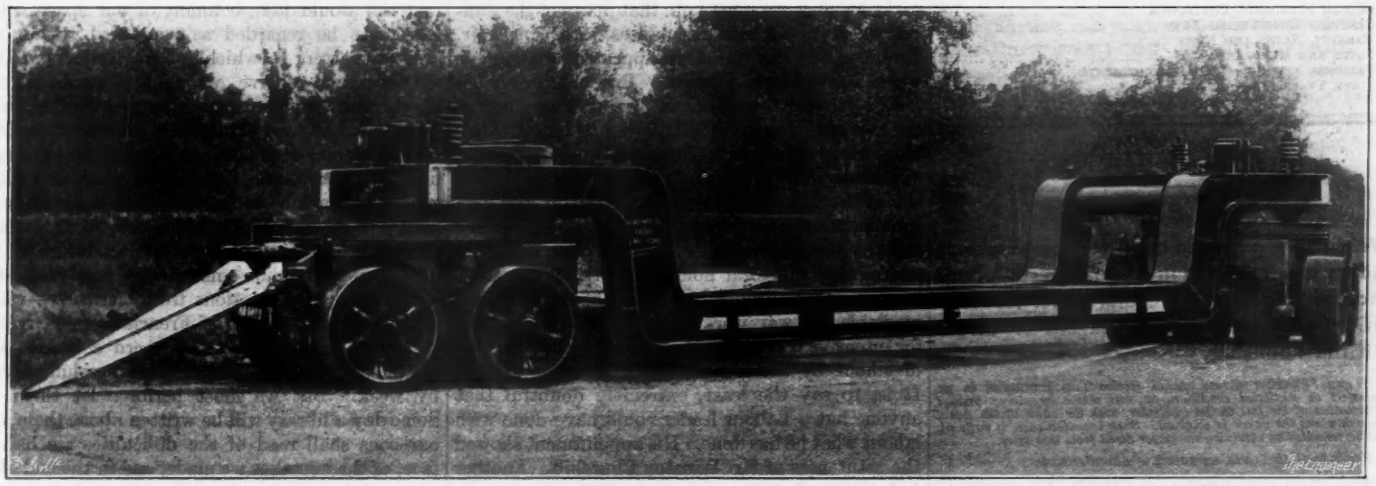
At the back of each bogie three small wheel valves are arranged to give individual control to any row of wheels ; for instance, looking towards the bogie from the rear, the wheel valve on the left controls the nearest row of wheels and by turning in a clockwise direction will shut off the fluid supply from the furthermost row of brakes. The centrally placed hand wheel is for use only in the event of one system developing a fault and normally it is intended that all three wheel valves should be fully open. Should trouble be experienced owing to the load transference tendencies of this type of bogie, such as flats occurring on the trailing tyres, it is possible to shut off the fluid pressure from the leading wheels of each bogie. The brakes of one bogie are not coupled to the braking system of the other, but are controlled individually.

As previously mentioned, the ground clearance can be varied within certain limits. This adjustment is achieved by the use of a single 70-ton hydraulic jack incorporated at each end of the main frame above the king pin. The necessity for this arrangement arises because the main frame had to be built with a low ground clearance to admit of loaded transformers passing under railway bridges. The ground clearance is not sufficient to allow the vehicle to pass over exceptional hump bridges and thus the frame and the load has to be lifted to obtain the necessary clearance. The load may be dropped again as soon as the hump bridge has been negotiated. The jacks are of the standard ship type with the pump box reversed, and they operate on oil. They are easily removable from the cast steel housing in which they are bolted and are quite independent of the king pin.

The lower end of the king pin is in the form of a steel ball fitted into a cast steel slide block, the latter having two pinning positions. A single pin is provided at each end of the frame for this purpose. The pin is intended to anchor the frame to the bogie, but the load is transmitted through a collar which is supplied loose in the equipment box for this purpose. Two collars are provided and they are intended for bolting between the underside of the king pin housing and the shoulder of the king pin. For use on uneven roads a single further collar is provided, which is approximately 1½in. thick and intended to give a limited three-point suspension to the whole vehicle. It is intended that it be employed on the leading king pin. A phosphor-bronze socket, which is sunk into the centre of the bogie, takes the weight of the king pin and this socket may be filled with heavy oil or a fluid grease. The ball is held to the socket by means of a grooved collar and two horizontal pins. These pins pass through on each side of the king pin and when removed the frame may be jacked clear of the bogie.

On each side of the king pin is provided an Acme thread screw jack. These jacks are intended to give lateral support to the main frame and also to provide rigid contact with the turntable when the frame is being lifted by means of the hydraulic king pin jack. They may also be lifted to give a certain amount of three-point suspension. A massive bronze nut is enclosed in the steel casting incorporated in the frame and a locknut is provided at the top of this casting. The thread is protected by a concertina sleeve and the screw may be operated with this sleeve in position. The lower end of each screw jack is connected to the turntable by a pin and self-aligning phosphor-bronze bush fitted in a cast steel sliding block. The latter is in contact, but not connected with the jack screws.

The wheels of these trailers are six-spoked steel castings and are fitted with solid rubber tyres, 771 mm. fitting diameter by 15in. wide, and taper roller bearings. The springs are of the progressive type and oscillate in special cast steel gudgeon brackets. The latter arrangement is the subject of a patent. The low oscillating point principle is employed and the ends of the springs are surrounded by large-diameter gudgeon bushes. These features, it is claimed, ensure that the spring is always under the load. Spring bolts are 1½in. diameter and the bottom spring bolt plate is of larger dimensions than is usual in order to give sledge action should the wheels sink into the ground. The gudgeon bearings are fitted with detachable caps and when these are detached the axle, complete with wheels, brakes and springs, may be readily withdrawn from the bogie.



80-TON SIXTEEN-WHEEL TRAILER

The Engineer

SEPTEMBER 6, 1940

VOL. CLXX No. 4417

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DEATH

ON September 3rd, 1940, at Gerrards Cross, Bucks, DR. HENRY STROUD, Emeritus Professor of Physics in the University of Durham.

A Year of War

IT is just a year since the war began. Possibly the strangest year in history. For several months little or nothing happened—overtly. The adversaries gazed at each other across their defences, bombarded each other with pamphlets, hurled threats and insults over the ether, photographed each other's terrain, and occasionally fired off a few rounds, or sent out a handful of men to catch a couple of prisoners. History may reveal the reason of this long pause. Germany was fully prepared with men and material for an assault. Great Britain was far from ready; the Empire was not ready at all; America was in no condition to help the Allies. Had Hitler attacked there and then it is conceivable that he might have been able to win a *blitzkrieg* in a few months. Why did he hold his hand? Had he been more severely mauled by his preceding campaigns than we knew, did he overestimate the strength of the Maginot Line, or—which seems most likely—was he not satisfied that his traitorous strategy in Norway, Belgium, Holland, and France was yet ripe and that he had "won the battle before a shot was fired" by dislocating and disrupting in many subtle ways the homogeneity of his opponents? Whatever its cause, we of the British Empire may be profoundly thankful for the delay. "Time was on our side," as the saying went, not so much because our blockade weakened the Reich, but because it gave us a breathing space in which to organise our resources and to mobilise men for the front line and the factory line. Critics tell us that we started far too slowly and that even to-day after twelve months we are leaving undone much that ought to be done—materially and financially. Do they forget that human affairs are very like physical affairs? That inertia is inevitable and inescapable? In lay speech, "inertia" implies contumely; but science recognises in it just natural fact, with no sinister implication. It may be that this scientific meaning is the juster one of the two, even in matters over which man is presumed to have control.

However that may be, we have the fact that after a slow start acceleration began to take place rapidly and is augmenting daily—only a few days ago, to give an example, Lord Beaverbrook was able to announce that in the preceding week a new record in aircraft production had been reached. There was a change of government. With every wish to avoid embroiling ourselves in politics and party feelings, we must note that many of the difficulties, obstacles, and resistances with which Mr. Chamberlain was faced disappeared like magic when Mr. Churchill became Prime Minister on May 10th and took Labour personalities into his Cabinet in charge of Ministries. Mr. Bevin's handling of labour is a glowing example. By tact and firmness he persuaded or obliged labour to do things that it had resolutely refused to do, and by a succession of enactments has in the past three months since intense warfare began increased enormously the total hours of work, taken steps to ensure that all skilled men shall be made at once available for war work, extended the machinery for intensive training, and arranged for the dilution of labour by the greater employment of women. It is, to say the least, extremely doubtful that anyone but a Labour leader could have done with labour what he has done. His appointment showed the astuteness of Mr. Winston Churchill. Another Labour appointment was that of Mr. Morrison as Minister of Supply. That Ministry has been criticised freely and often justly, but no one has questioned the energy, alertness, and determination of the Minister himself. The plain fact is that the Ministry is, or was, cumbersome, bringing too great a variety of matters under one control. Moreover, unlike Mr. Bevin, who is intimately familiar with all labour problems, Mr. Morrison can have no more than a nodding acquaintance with the thousand and one things that fall under the heading of supply. His Ministry is therefore administered by Controllers in charge of matters which seem to be wholly unrelated. There are, in fact, no less than seventeen Controllers directly under him, and several more that are partly related to his Ministry. The most important of the manufacturing industries which operate independently under its own Minister is that of Aircraft Production, of which Lord Beaverbrook is head. His lordship is not a technical man. Probably he knows little or nothing about the production of anything but newspapers; but he has energy, drive, and forcefulness—qualities that Mr. Churchill sought at a moment of grave necessity. On the production side he has at his right hand Sir Charles Craven, whose remarkable gift for the management of men and works is well known; he was appointed Chairman of the Air Supply Board on April 22nd, resigning his connection with the Vickers companies to give all his time to his new post. On the aeronautical side, the Air Supply Board has Air Marshal Sir Wilfrid Freeman and Air Marshal Sir Christopher Courtney, besides several civil members with technical knowledge. It will be seen from this that Lord Beaverbrook is provided with a body of men capable of responding to every call that he and the country may make upon them.

It is common knowledge that in no direction has a greater task been achieved than in the production of aircraft, but though less attention has been given to it, it would be grossly unfair to overlook the magnificent work achieved by the Director of Munitions Production, Sir Harold Brown. Originally attached to the War Office when it was created in 1936, Munitions Supply is now under the Minister of Supply, and has been separated into several components. Let it but be recalled that it was upon this department and its subsidiaries and auxiliaries that fell the burden of providing the technical equipment of the B.E.F. after the Dunkirk evacuation, and that it is responsible for the output of the weapons and munitions that are being assembled for the time when the Allies take the aggressive on land, as they have already done in the air. Remembering these facts, the importance of its work, which has been overshadowed for the time being by the war in the air, will be recognised as it deserves to be.

Of the third arm, the Navy, it is impossible to say much from the technical side. A thick curtain has been drawn over all the operations of the Admiralty, and to raise even a corner of it would be improper. The Navy must be known by its works, and of them we give some account in an adjoining column. Not till the war is well over will the splendid work the Admiralty has done, is doing, and will continue to do, be revealed.

To speak of the thousand and one things that have been done to accelerate the output of war material would take columns of our space. The less must be regarded as contained within the greater matters to which we have alluded. Had we the space to give, we might describe all the efforts that have been made to mobilise the engineering talents and skill of the country and of the methods which are being employed to direct science upon vital problems. We should speak also of the supply of machine tools, which vexes so sorely all branches of engineering industries, of the efforts to maintain a fair margin of export trade, of the dearth of aluminium—now being partly satisfied by unwilling importations from Germany—which followed upon the loss of French bauxite, and of many other things which concern engineers and which have been duly recorded in our columns week by week. But we must perforce let them go. Some day a library will be written about them, and our sons shall read of the difficulties we had to face, of the mistakes we made, and in the end of an accomplishment that far outweighed all faults and failings. The critics will say we "muddled through" as usual. Let them. If "muddling through" wins out in the end, it must have qualities that puts it a little above the highest organisation. Perhaps, after all, "muddling through" is not the right name for a flexible and very accommodating system.

It is, as we have said, not permissible to speak in specific terms of what has been achieved by the efforts to which we have referred. But we know from the lips of Cabinet Ministers that already the loss of equipment which occurred at Dunkirk has been practically made good, and it is a safe surmise that the piling up of war material for the great offensive has begun. The long vision is being taken; Mr. Churchill and Mr. Eden have made that clear. We are not counting on an early collapse of either of our enemies, Germany or Italy. Our preparations are being made for an event two or even three years ahead. By that time the vast power and reserve of power of the British Empire will have been developed, and the lesser but very valuable power of those Allies who have been true to the cause will have been co-ordinated and combined completely with ours. In that day the force that can be brought to bear on Nazidom and Facism will be stupendous, and the result should not be in doubt. It is for that day that we are working. Let there be no doubt on that point. The Battle of France is over and done with; the Battle of Britain is raging; the Battle of Germany is to come. Already even when we are defending ourselves we are attacking our enemies with two hands. Our right strikes at Germany by nightly air attacks of magnificent boldness, whilst with our left we hammer Italy on the sea and from the clouds, not only within her own boundaries, but in her African possessions. Those who profess to believe that we are concerning ourselves solely with the defence of this "wingéd sea-girt citadel," do not know the

spirit that is moving in the British Empire and stirring in all those lands and peoples allied by love or by blood with it. We, this federation of free peoples, have a sense of the greater duty that has fallen upon us, and us alone, since the collapse of France. We in Britain are fighting to defend ourselves and our homes, it is true, but we are fighting also to preserve the workshops of this land so that when the time comes to enforce our will upon the tyrants we may be no less wanting in the material of war than in the spirit that leads to Victory.

A Year of War at Sea

AT sea the war, though in detail it has differed widely from that of 1914–1918, has reaffirmed the broad principles of sea power upon which British naval strategy is founded. Both wars began with the Fleet fully mobilised.

Our superiority in capital ships has deterred the enemy from risking anything in the shape of a general action, in which respect this war bears a superficial resemblance to the last. Though capital ships met at the Dogger Bank and at Jutland, on each occasion the enemy used every endeavour to avoid fighting so long as it was plain that the odds were not heavily in his favour.

Capital ships have so far met only twice at sea. On April 9th the German battleship "Scharnhorst" fled from H.M.S. "Renown" after a brief and inconclusive exchange of gunfire in weather conditions which facilitated her escape. Though she was supported by a 10,000-ton cruiser, the "Admiral Hipper," all the facts go to show that the "Scharnhorst," while almost certainly faster than the nominal 27 knots with which she has been credited, is a less formidable opponent than the recent date of her construction might suggest. There is probably some ground for the belief that the object of the "Scharnhorst" was to divert the British ship's attention from enemy proceedings at Narvik on that date. Had the "Renown" gone direct to that port without encountering the "Scharnhorst" she might well have upset completely the German plans, besides rendering unnecessary the two actions which were fought there later in the same week.

In the long-range action between the British Mediterranean Fleet, under Admiral Sir Andrew Cunningham, and an Italian squadron, including the battleships "Cavour" and "Cesare," the same desire to avoid conflict was manifest. Though the British superiority in capital ships appears only to have been three to two, the enemy at once retreated to the shelter of his mine-defended ports. A single 15in. projectile which hit one of the Italian battleships is admitted to have caused nearly 100 casualties.

At Mers-el-Kebir a British force under Vice-Admiral Sir James Somerville comprising three capital ships—said by the French to have been H.M.S. "Hood," "Warspite," and "Resolution"—took only a quarter of an hour to place the "Dunkerque," "Bretagne," and "Provence" *hors-de-combat*. It is true that the resistance put up by the French was negligible, but even so the result is somewhat surprising, and argues well for the accuracy of British gunfire. No one can fail to regret bitterly that it should have proved necessary to turn upon a former ally in this way, but the risk of these capital ships, together with the "Richelieu," dealt with later at Dakar, passing into German or Italian hands was too grave to be ignored.

Undoubtedly we can count ourselves lucky to have lost only one battleship—H.M.S. "Royal Oak"—in the first year of war. Eight were sunk in the corresponding period of 1914–18.

Aircraft carriers have incurred heavier losses, in proportion to their numbers, than any other category of warship, but this does not imply that they are to be considered a failure. On the contrary, the experience gained by H.M.S. "Ark Royal" during the hunt for the "Admiral Graf Spee" in the South Atlantic afforded proof that they are very valuable ships when used for their proper purpose—which is not submarine hunting, the operation in which the "Courageous" was sunk in the first fortnight of the war. It will probably be found, too, when history comes to be written, that the loss of her sister ship, the "Glorious," in June, affords no ground for condemnation of aircraft carriers as a type.

Compared with 1914–15, the number of cruisers lost has been very small. Even if the anti-aircraft ship "Curlew" is counted as a cruiser the total is only three, exactly one-third of the number destroyed during the first twelve months of the last war.

It may here be pointed out that to a combination of good luck and the highest professional skill and courage on the part of Rear-Admiral Sir Henry Harwood and his Captains must be credited not only the surprising survival of H.M.S. "Exeter," "Ajax," and "Achilles" in action with a ship which on paper might have been expected to have sunk all three, but also the decisive defeat of the enemy "pocket battleship." Indeed, there has been nothing in the whole course of the war at sea more heartening than this fine action, in which the three cruisers mentioned proved themselves worthy successors of the "Indefatigable" and "Amazon" in their conflict with the "Droits de l'Homme" in 1797, and of the "Penelope" with the "Guillaume Tell" in 1800.

Destroyer casualties have been fairly heavy, though not excessive when it is realised that these gallant little vessels have been in action more frequently than any other category of warship, their speed and handiness causing them to be in request for every sort of operation. Altogether thirty destroyers have been lost, about one-sixth of the total in service at the opening of hostilities. However, the German loss in these craft totals eleven, which is 50 per cent. of the number with which our foes started the war and we have just acquired fifty elderly but still useful destroyers from the United States.

In the two battles of Narvik British destroyers well maintained the high reputation that they earned for themselves in the last war. Later, in the Narrow Seas, they played an equally prominent part in the operations on the Dutch and Flemish coasts, culminating in the amazing withdrawal from Dunkirk. Altogether twelve destroyers have met their end as the result of damage received in action with enemy aircraft, a fact which makes it plain that future designs must provide for a greatly augmented armament of high-angle guns.

Submarine losses have also been considerable, amounting to fifteen out of the fifty-eight with which the Royal Navy began the war. But they have been as nothing compared with the destruction of U-boats, which, it is believed, cannot fall far short of the total strength of seventy-one with which Germany was credited a year ago.

One of the most valuable lessons learned in the last war was that the convoy system may be relied upon to limit the losses inflicted on merchant shipping by ruthless and unrestricted submarine attack. Wisely, as it proved, preparations had been made to put this system in force as soon as hostilities began, and by the third week in September, 1939, a very large proportion of the merchantmen passing through the danger zone were under escort. To that fact is due the welcome news, imparted by the Minister of Shipping in a recent speech, that although from every cause, including marine hazards, 1,900,000 tons of British shipping have been lost since the war began, vessels added by new construction, capture, and purchase amount to fully 2,000,000 tons.

Thus the end of the first year of naval warfare sees the British Fleet in control of the situation not only in Home Waters, but also in the Mediterranean and on every foreign station. While that remains the case there cannot be the slightest doubt as to the ultimate issue of the war.

War in the Air

THE history of the naval side of the war has so far been almost entirely a record of British activities and achievements against the enemy at sea. It is otherwise in the case of the war in the air. The campaigns in Poland, Finland, Norway, the Low Countries, and France all provide chapters in the story and although the events which, up to the present, have marked our own share of the war in the air naturally seem to us to be the most important, an impartial historian, surveying the first twelve months of the war, will certainly not regard them as constituting the principal part of the story. It may and probably will be true, however, that in the chapter which he will write on Britain's share in the first year of the war, and particularly in that section of it devoted to August of this year, he will find much of prime significance for its bearing on the concluding chapter of his completed history.

Taking a wide survey of the past twelve months' aerial warfare, there is clearly visible a picture of growing difficulties for the enemy. The short Polish campaign was almost a "walk-over" for the German air force. The attack from the air began in the early hours of September 1st, before the Poles were aware that a state of war existed. All the aerodromes on the western frontier were bombed, aircraft on the ground were destroyed, railway junctions were crippled, mobilisation was interrupted, and aircraft factories reduced to ruins. It may be truly said that by their initial lack of scruple and not by the bravery of their airmen or the excellence of their equipment, the German air force succeeded in reducing their Polish opponents to a condition which would have speedily ended in surrender even if the Russians had not seen fit to deliver the final stab in the back. The relative ease of the German *Luftwaffe's* task in Poland may be gauged from the fact that its total losses of aircraft are stated not to have exceeded about 420.

The Finnish campaign revealed the inefficiency of the Russian air force. Although Germany did not participate in it actively, British aircraft with Finnish pilots took part in its later stages, Gloster "Gladiators," a somewhat obsolescent type, proving highly effective against the Russian machines. They were, however, available in numbers too small to affect the final issue, and Finland, after a heroic struggle involving sustained bombing of her principal towns and centres, had to lay down her arms.

The invasion of Norway was facilitated by the use of troop and store-carrying aircraft, but it cannot be said that it was primarily dependent on air transport. On the other hand, the failure of our military effort to stem the conquest was undoubtedly the result of our inability to maintain fighting aircraft on the other side of the North Sea. Repeated bombing attacks on the aerodromes at Stavanger and elsewhere which had been seized by the enemy exposed him to severe loss, but did not prevent him from using his bombers in an effective manner against our troops. Our fighters were of insufficient range to reach the west coast of Norway, and return to this country after an engagement or patrol. An effort was made to establish a landing ground on a frozen lake, but was soon defeated by the attack of the enemy. Later, we employed aircraft carriers off the coast, but the plan exposed our ships to great risk, and eventually just as we were withdrawing our expeditionary force, led to the loss of H.M.S. "Glorious."

The German attack on the Low Countries involved in its initial stages a striking use on a large scale of parachutists dropped from aircraft at many key points. These men succeeded in seizing some aerodromes and prepared the way for the landing of reinforcements brought by troop carriers, who, in turn, were speedily backed up by the advance of mechanised land forces. The ensuing campaign was conducted by the Germans with unspeakable savagery against civilian refugees, who, without pity, were bombed and machine gunned as they fled in herds along the roads. Undoubtedly, this despicable plan contributed in an important degree to the swiftness with which the Germans brought Holland and Belgium to the point of capitulation. In the ensuing Battle of France, the German air force found itself for the first time seriously opposed by enemies not prepared to admit its superiority in fair combat. It suffered heavy losses and had the outcome of the campaign been dependent solely on air power it seems very probable that France to-day would still have been fighting as a united country at our side.

The British Expeditionary Force which had moved into Belgium was forced to retreat to the coast after King Leopold's act of surrender. Its safe evacuation from its perilous position was effected primarily by the heroism of our sea forces

assisted by the R.A.F., which for several days maintained a decisive local air supremacy over the enemy, which prevented him from seriously interfering with the re-embarkation of our men.

With the surrender of France and with Italy added to our foes, this country not only stood firm, but doubled and redoubled its efforts to meet the storm which it was anticipated would soon fall upon it. Our shores were now exposed to invasion by sea and air to an extent which at first seemed to many to doom us to great trials. The enemy, however, in need no doubt of a period for reorganisation, allowed us an equal period for preparation. Not until August 8th did he make the first serious move against us. It took the form of aerial attacks on our shipping in the Channel. Mass raids against inland objectives followed, but from the first it was evident that the R.A.F., although outnumbered, was not outclassed by the Germans. Heavy defeats were inflicted on the enemy. Since the first mass attack from the air on this country on August 8th, 1100 enemy aircraft had been destroyed up to September 2nd. During the same period the R.A.F. lost 314 machines, but 158 of the pilots were saved. All in, since the outbreak of the war to the end of the first year, the R.A.F. has destroyed 1752 enemy machines in the defence of Great Britain, while anti-aircraft gunners have accounted for a further 196. The official figures for the enemy losses, as is well known, are very carefully sifted, and undoubtedly err on the side of modesty.

Meanwhile, with our rapidly growing output of aircraft and the influx of trained pilots and crews we are carrying the air war into the enemy's territory with ever-increasing strength. Consistently and methodically, each night, even when the weather is unfavourable, our bombers are penetrating deep into Germany, and frequently into Northern Italy, and are wrecking or damaging innumerable war factories, oil plants, flying grounds and vital railway and canal communications. Between May 10th, the date on which the Germans began their attack on the Low Countries, and August 21st, it is estimated that the Royal Air Force has made 598 raids against 178 places in Germany and 206 places in German-occupied territory. During these operations about 158,000 bombs were dropped on military objectives, nearly 100,000 of them within Germany itself. Enormous damage, it is certain, has been done, much exceeding what Germany has so far inflicted on this country.

It is too early yet to say that the tide has turned in our favour, but it has been stated officially that our output of aircraft now exceeds that of Germany and that in time we will achieve, first parity with her air strength and then superiority. During the past few nights our bombers have reached out to the Berlin area, and have delivered successful attacks against it. As the nights grow longer and our striking force increases in strength, our aerial offence against our enemies will extend in scope and power, until, it may reasonably be hoped, it will reduce the enemy to a state favourable to the attainment of our aims.

The position is still grave, but if we cast our minds back to the time of the Dunkirk evacuation and review what has been since done by this country and what the enemy has failed to do, we will find much for which to be thankful, much to give us sound cause for encouragement, and much—very much—to make us proud of our nationhood.

Obituary

SIR J. J. THOMSON

EIGHT days after the death of Sir Oliver Lodge we have to mourn the death of another celebrated British scientist, Sir J. J. Thomson, who died on August 30th, at the age of eighty-three—six years short of the span attained by Sir Oliver.

Joseph John Thomson was born at Cheetham, a suburb of Manchester, on December 18th, 1856. Following a period of elementary schooling, in which the Eton Latin Grammar played almost as large a part as it did in Oliver Lodge's preliminary education, he set out at the age of fourteen to begin a career as an engineer. It was intended that he should be apprenticed to Sharp, Stewart and Co., but there was a long waiting list, and to fill in the time he was sent to Owen's College, Manchester, to take the engineering course. He studied engineering under Osborne Reynolds, but it was Balfour Stewarts' lectures on elementary physics which aroused his chief interest. He remained five years at the College, but at the end of his second year his father died and as his mother was unable to afford the heavy premium required for his apprenticeship the idea of his becoming an engineer was abandoned. With the aid of some small scholarships which he had won he completed the three years' engineering course. He then concentrated on mathematics and physics for a year with the object of obtaining an entrance scholarship to Trinity College, Cambridge. On his first attempt he failed, but a year's further study brought him success in 1876, when he was awarded a minor scholarship of £75 a year and a subsizarship accompanied by certain allowances. At Cambridge he studied mathematics and physics under Routh, Glaisher, Cayley, Adams and Stokes. In January, 1880, he took the mathematical tripos examination and came out second wrangler, Larmor being senior.

After taking his degree Thomson began to prepare a dissertation for the fellowship examination. The subject which he chose was the nature of energy, and in the course of his dissertation he expounded the view that all energy was kinetic energy. He was successful at the first attempt. He now began to take some private pupils, among whom was Austen Chamberlain, and about two years after taking his degree he was elected to an assistant lecturership in mathematics at Trinity College. About this time he started work on some mathematical investigations on moving charges of electricity. In 1882 he won the Adam's prize for a paper on the motion of vortex rings, a subject at that time of great interest in view of Lord Kelvin's recent suggestion that matter might be composed of vortex rings in a perfect fluid. During this period he began to work in the Cavendish laboratory. There he worked under Lord Rayleigh and at his suggestion began a lengthy and difficult investigation designed to determine the ratio of the electrostatic to the electro-magnetic units of electric charge, a ratio which, according to Maxwell's theory, ought to be equal to the velocity of light. In 1883 he was elected a University Lecturer and discoursed on electrostatics and electro-magnetism and also on rigid dynamics, statics and attractions. In the spring of 1884 he was elected a Fellow of the Royal Society and a few months later, on the resignation of Lord Rayleigh, he was, greatly to his own surprise, elected to succeed him as Cavendish Professor of Experimental Physics. In that position he had, while still under the age of thirty, to follow in the footsteps not only of Rayleigh, but of Clerk Maxwell.

Immediately after being elected he began in conjunction with Threlfall some experiments on the passage of electricity through gases. Those were his first experiments on the subject and opened up a field of research which he continued to study for the rest of his life. His idea at first was that when a gas conducted electricity it did so by virtue of some of its molecules splitting up into two atoms, one of which carried negative and the other positive electricity. It was not until 1897 that he discovered that of the bodies into which the molecule split up the one carrying the negative electricity was quite different from an atom and in particular that its mass was less than one-thousandth part of the mass of a hydrogen atom. To these bodies the name "corpuscles" was at first given, but to-day we know them as electrons. The discovery that atoms were not indivisible, that the electrons which could be torn from them all possessed the same mass whatever the chemical nature of the atom, and that all electrons carried the same charge of electricity, revolutionised physical theory and provided Thomson with a vast field of study in a domain admirably suited to his experimental and mathematical genius. This is not the place, nor does the opportunity serve, to write a detailed account of Thomson's contributions to modern physics. It must suffice to say that optics, magnetism, spectroscopy, radio-activity, photo-electricity and thermionics receive fresh illumination by his discoveries and that his place in the history of physics is assured for all time.

Many honours naturally fell to him. In 1908 he was knighted and a few years later received the Order of Merit. In 1918 he was appointed by the Crown to succeed the late Dr. Butler as Master of Trinity College. On his appointment as Master of Trinity he resigned the Cavendish Professorship and also the Professorship of Physics at the Royal Institution, to which he had been appointed in 1905, in each case, however, retaining the rank of honorary professor. He received the Nobel Prize for Physics in 1906 and the Copley Medal of the Royal Society in 1914. Of his two children, his son, G. P. Thomson, has been Physics Professor at the Imperial College of Science since 1930.

Like Sir Oliver Lodge, Sir William Crookes, Lord Rayleigh and some other eminent physicists, Thomson took more than a passing interest in psychical research, and while his belief in certain alleged manifestations from the spiritual world was tempered with scientific caution, he believed in the possibility of telepathy—at least at short range—and held that it might have a close connection with physics.

LORD HORNE OF SLAMANNAN

MANY of our readers will learn with the deepest regret of the sudden death, on Tuesday afternoon, September 3rd, in Surrey, of Lord Horne, following an operation for appendicitis. Sir Robert Stevenson Horne, P.C., K.C., the first Viscount Horne of Slamannan, of Slamannan, County Stirling, was chairman of the Great Western Railway Company, a former Chancellor of the Exchequer, and the director of many important business concerns. Lord Horne, who was only sixty-nine years of age, was born at Slamannan and was the youngest son of the late Rev. R. S. Horne, the parish minister. He received his education at George Watson's College in Edinburgh, and at Glasgow University, where he had a career of outstanding brilliance. He decided to follow the law as a career, but in 1895, while reading law, he accepted a post as Professor in Philosophy in the University of North Wales. From 1896 until 1900 he was examiner in philosophy in the University of Aberdeen. He was called to the Scottish Bar in 1896 and took silk in 1910. He entered political life at the beginning of the last war, first as Secretary of the Agricultural Section of the National Service Department. At a later date he was Director of Railways at the front under Sir Eric Geddes, with the rank of Lieutenant-Colonel. He showed an unusual talent for organisation, and in 1917 became Assistant Inspector-General of Transportation. Subsequently he was appointed Director of Material and Priority at the Admiralty. At a later date he became Director of the Admiralty Labour Department and Third Civil Lord. He was returned to Parliament for the Hillhead division of Glasgow in December, 1918, and was immediately raised to Cabinet rank, becoming Minister of Labour. From 1920 to 1921 he was President of the Board of Trade, and then became Chancellor of the Exchequer, a position he continued to hold until the fall of the Coalition Government in 1922. He was honoured by the bestowal of the K.B.E. in 1919 and became a member of the Privy Council. In 1920 he was made G.B.E. and he was raised to the peerage in 1937. In 1921 he was made LL.D. of the University of Edinburgh and he served the Aberdeen University as Lord Rector from 1921 to 1924. His business interests took him into wide fields. He was on the board of the Suez Canal Company, the P. & O. Company, Lloyds Bank and the Commercial Union Assurance Company. He was the chairman of the Great Western Railway Company, the Burma Corporation, the Zinc Corporation and the Imperial Smelting Corporation. Lord Horne made friends wherever he went and kept them. He possessed great charm of manner, was an admirable host, and into his speeches he introduced a touch of pawky Scottish humour, which, whilst it added to their attraction, was never allowed to interfere with the matter he had in hand. This facility for getting on with his fellow-men combined with a great capacity for work and unbounded energy raised him to the great positions he occupied.

BOOKS RECEIVED

Hydro-electric Power Commission of Ontario. Thirty-second Annual Report. Toronto: T. E. Bowman.

Purchase Tax Table. London: Edwards and Smith (London), Ltd., 1, Drapers' Gardens, E.C.2. Price 1s. 3d.

New Techniques for Supervisors and Foremen. By Albert Walton. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 16s. 6d.

Molesworth's Pocket Book of Engineering Formulæ. Edited by A. P. Thurston. Thirty-first edition. London: E. and F. N. Spon, Ltd., 57, Haymarket, S.W.1. Price 7s. 6d. net.

The Intensive Use of Locomotive Power

THE rate of use of the locomotive power of any railway is dependent upon two things, availability of power and availability of traffic, and although considerable attention has recently been paid to this, perhaps the most important feature of railway operation, much remains to be done if returns such as "Engine Miles per Train Hour" convey a true message; it may be remarked in support of the above statement that a survey of other than passenger train locomotive working in this country in normal times would show that its engines are idle in steam for well over half their time from shed to shed and it may be taken for granted that if the freight engines (excluding shunting power) were added in the proportion given would be further depreciated. So much for the traffic side of the question; from the engineering side availability is dependent on the quantity arising and the rate of repairs effected added to the time required for the usual routine inspections and attentions, such as refuelling, cleaning, tube sweeping, and washing out the boilers. A great deal of thought and money has recently been expended on plant and methods in connection with the acceleration and at the same time diminishing the incidence of these requirements; but while admitting the value of the improvements effected, it must be said at once that it is of little use to save minutes in the shed if hours are to be wasted on the road. The whole art and science of arranging engine workings is to see that the engine devotes as much of its time as possible to the actual haulage of trains; if, however, the trains are badly spaced economical operation becomes difficult.

Turning back to the engineering aspect, it is doubtful whether much further improvement in the time required for effecting repairs is possible. Service and general repairs are nearly always determined by the state of the tyres, as it is seldom that the condition of boiler or running gear cannot be stretched a little to meet the tyre life, which is pretty accurately known on every railway; these two classes of repairs have as a general rule been removed from running sheds and centralised in better equipped area workshops, in which all avenues of acceleration in rate have by now been thoroughly examined. The centralisation in efficient shops, in addition to shortening the average time off the road "under or awaiting repairs," has allowed the running shed managements to concentrate on their proper tasks of operation, routine inspections, and strictly "running" repairs; these may be described as the periodical and casual repairs and adjustments not requiring the lifting of the engine or boiler necessary to keep the engine on the road. An observable trend to-day in this respect is the effort to confine these repairs and inspections to a regular period during which the engine is automatically "stopped" out of traffic, a preliminary comprehensive inspection under and out of steam being made at this time and any detail considered as unlikely to last out for the whole of the next running period being repaired or scrapped, as the case may be, in addition to those definitely defective; the underlying idea being that it is better economics to scrap or repair the detail slightly before the limit is reached rather than to spoil the regular turn of availability by a special stop for the purpose. This stop period should naturally coincide with the washing out of the boiler, although not necessarily of the same frequency.

As regards further shed services, power-driven turntables capable of turning the largest engines in two or three minutes are steadily being installed at all major points and the same may be said of modern coaling plants; these consist of one or two very large overhead bins having an electrically operated shaker underneath fitted with a dialling and recording apparatus which automatically prints on a continuous roll of paper the hundredweights of coal shaken down, the average ratio of a shake to its weight being determined in advance by experiment and then worked on. The shaker is set in motion by dialling the engine number, which is also automatically printed on the roll at the head of the quantity taken. This system has gone a long way beyond the quite recent (Colonial) experience of the writer, in which the coal was carried on to the tender in baskets alleged to weigh 90 lb., the carrier throwing a pebble per basket into a bucket (one per man), on which he was in fact actually paid at the rate of so much per pebble, the weight at 90 lb. multiplied by the number of pebbles being debited against the engine. Needless to say, the booked and actual weights were always at variance.

Cleaning, which unfortunately seems more honoured in the breach than in the observance, is a process that could stand a little mechanisation; the common method appears to be that of cloths and hand labour, both of which, judging from appearances, being sparingly applied. It is suggested that the use of "guns" using very hot water at high pressure, or alternatively a mild caustic solution, followed by mechanical wipers consisting of revolving cloths at the end of a flexible shaft, could be used with advantage to time, cost, and appearance; the more awkward corners, while susceptible to the effect of the jet, would still need after-wiping by hand, but the mechanical gadget would be usable on quite nine-tenths of the surface of engine and tender.

The washing-out of the boiler is in present practice generally closely connected with the chemical treatment of the boiler feed waters. As, in the writer's opinion, the combination of washing-out and water treatment is probably the most important scientific, as distinct from operating, problem in connection with locomotive running at the present time, it is proposed to review it fairly closely. Washing-out is undertaken to overcome two evils—the concentration of soluble salts in the boiler, which if allowed to become too concentrated may be expected to set up a condition likely to cause priming; and to remove as far as possible the loose and semi-loose scale deposited on evaporation in the boiler. It is a periodical process based on local experience of mileage run or time in steam and waters taken; sometimes if priming appears imminent prior to the usual date for washing-out the driver will book the water in his boiler to be changed by the shed staff or will reduce concentration by blowing-down *en route* as and when opportunity offers, using the cock provided for the purpose. A driver can detect this tendency by observing the water in his gauge glass; most men prefer to leave water changing to the shed staff, as there is always a slight danger of scale jamming the blow-down cock open and so causing a failure. When untreated water is used for boiler feed, no amount of washing-out will clear out all the scale, and in time its removal will necessitate the removal of some or all of the small tubes for complete clearance to be effected. This is a slow and expensive process which under ordinary conditions of untreated water will be found necessary at 20,000 to 50,000 miles, according to the quality of the waters used and the intensity of the service. Correct water treatment should condition the water so that on evaporation in the boiler it neither deposits scale, causes corrosion, nor induces priming. Progress in locomotive practice has not been comparable with that in stationary plants, chiefly on account of difficulties in early days induced by the wide mixture of waters used. These, however, are avoidable if correct treatment is adopted and adjusted to suit the water at each particular watering station. The most important condition for success is that all the waters in the area to be covered must be treated, for it has been found that a mixture of raw and treated waters in the boiler increases the tendency to prime, so much so that instead of decreasing the incidence of washing-out and water changing a definite increase has been noted. During the installation stage of a complete series of plants, when some are in use and others under erection, it has been found necessary on the above account to limit the softening process of those in use to a residual hardness which gives a stable water comparable with other waters in the area as yet untreated. This compromise avoids priming, and in the case of most waters sensibly diminishes the deposition of scale.

The type of plant commonly used in this country employs the lime-soda process, the chemicals used being hydrated lime, soda ash, and usually a small amount of sodium aluminate. The correct use of these should produce a clear and stable water of low hardness. The process precipitates the hard scale-forming salts in the plant and the water leaves the plant with a slight excess of sodium alkalinity to prevent any corrosion. Unfortunately the sodium salts will concentrate in the boiler until that condition is reached when priming may be expected. Limitation of concentration is therefore a necessary corollary of the process and may be obtained by any of the three following methods:—Casual blowing-down *en route*, water changing in the shed, and continuously bleeding away a small proportion of the boiler water *en route* through a special type of valve. The last named, which is the process adopted by the L.M.S. Railway, seems the best, and is in effect a continuous hot washing-out process. The special valve referred to automatically opens and shuts in unison with the regulator by means of a steam balance, it being found unnecessary to blow down when no demand is being made on the boiler. The loss of water through blowing-down is negligible, and is governed by conditions of duty and composition of the waters used. Theoretically, the full treatment of all raw water supplemented by a satisfactory blowing-down system should avoid the necessity of washing-out the boiler altogether, but this stage has not yet been reached in practice. Mileages between washings-out of over 6000 in lieu of the former 500 to 600 have, however, been attained, and engineers acquainted with running-shed routine will realise the value of these results. Even better is the absence of stopping the engine for tube extraction and internal cleaning, a process running to several days. Better evaporation through scale-free heating surfaces is a small but persistent advantage, but the absence of pitting and corrosion are of very real value in the reduction of maintenance costs.

A further aspect taken in conjunction with the periodical repairs and inspection system already referred to is that there should be no need for the installation of hot washing-out plants, the routine inspections, &c., occupying sufficient time for the boiler to cool off in the ordinary way, be washed out, and steamed from cold. Referring to the cooling-off period, the L.M.S. Railway has recently introduced a system of injecting cold water into the boiler after the pressure has been blown off through the injector overflow pipe, the surplus being taken off through a hose coupled to an upper plug hole in the fire-box. An adjustable spring-loaded valve on the intake line controls the quantity admitted, this being laid down on a fixed scale for the various classes. The face of the valve is marked for the various rates of intake, and the intention is to conserve the life of the boiler by a regulated rate of cooling.

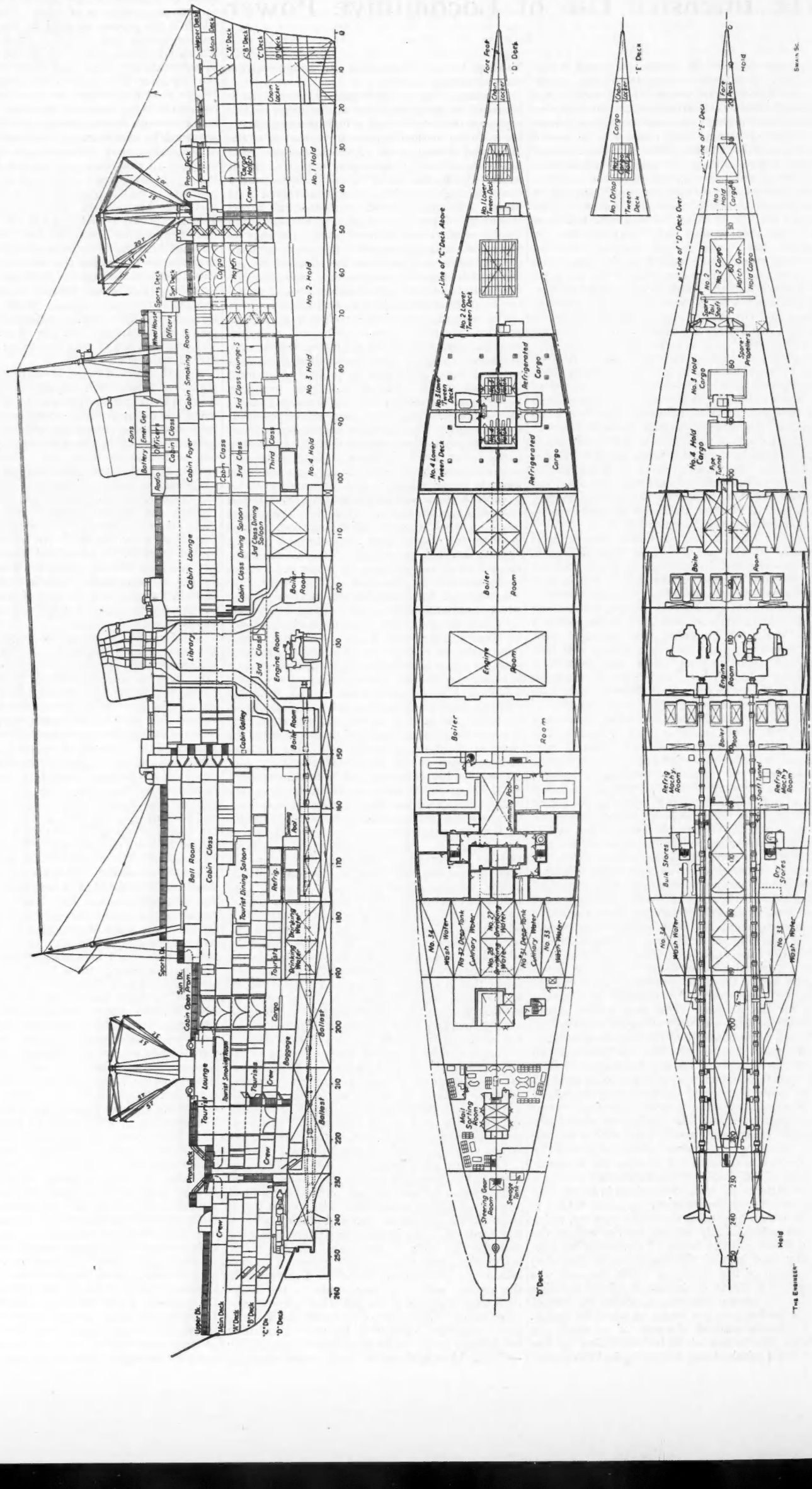
The foregoing sums up the engineering side of the possibilities of improving availability, but, as suggested in the opening sentence, there is a traffic side which certainly should not be overlooked by engineers. Referring in the first place to passenger services, a quite minor adjustment of train times would often allow an incoming engine to return with an earlier train, or, alternatively, to continue instead of being changed *en route*, an easy but expensive process. Again, in connection with main line junctions having branch services at both ends running into the usual bays (*cf.* Rugby). By running the branch trains through the station and backing them into the bays at the farther end, the engine would not be blocked in, and a second engine for working the train back again would not be required. The writer recently worked out this scheme in connection with a large junction in East Anglia, and found that in addition to saving the two releasing engines, the daily mileage of the remaining engines on the service was improved by 20 per cent. The shunting and disposal of the released engines would also be eliminated. No trouble was noted in connection with coaling or oiling-up services; these could be attended to elsewhere without difficulty. As regards freight services, a major cause of delay and lost mileage is the absence of the continuous brake throughout the trains. The lack of efficient braking severely limits speeds, and especially those of approach to signals, stations, &c. It is common knowledge that in many cases the braking distances are such that when working heavy unbraked trains the driver is compelled to have his train well under control in case the signal is against him when he sights it. The corollary to quick stopping is quick starting. It is fairly common knowledge that the recent institution of extra high-speed passenger trains accentuated this problem, which, dormant during the war, may be expected to crop up again. It may then be found good economics to fit all wagons with automatic brakes and with roller bearings, which are known to facilitate starting.

A final word on roadside shunting by freight train engines. This wastes much unnecessary time *en route*, and a good road engine is necessarily a poor shunter. There does seem an opportunity for the use of small I.C. one-man engines at many of the roadside yards carrying a sufficient traffic. Instead of spending an hour or two shunting out the yard, the train engine would be limited to two or three short shunts, with considerable improvement to the engine miles per engine-hour return.

UNITED STATES LINER "AMERICA"—PROFILE AND DECK PLANS

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, NEWPORT NEWS, VA., BUILDERS

(For description see opposite page)



The United States Liner "America"

No. II

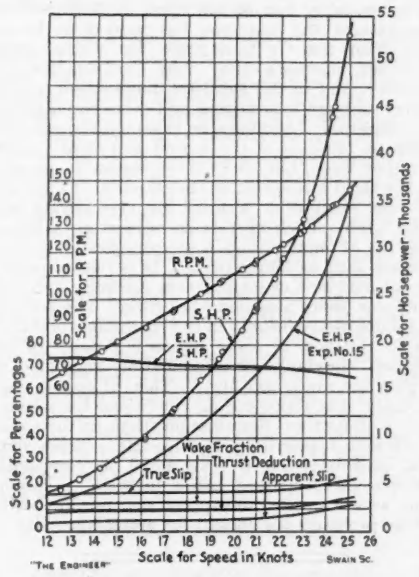
(*Continued from page 144, August 30th*)

IN this article we proceed with our description of the twin-screw 27,000 gross ton passenger liner "America," the flagship of the United States Lines. The ship, which was built by the Newport News Shipbuilding and Dry Dock Company, of Newport News, Virginia, left New York on Saturday, August 10th, under the command of Captain Giles C. Stedman, formerly the captain of the "Washington," on her maiden voyage to the West Indies.

In our last article we dealt with the ideas underlying the design of the ship and gave some of the principal dimensions and data regarding her construction, which was illustrated by four engravings showing the progress of the work from the laying of the keel up to the time of launching. Further particulars of the hull design may now be referred to.

Hull Design and Construction

The accompanying power and speed curves were derived from the self-propelled model tests, which were carried out in the United States Experimental Model Basin at Washington. From the profile view and the two deck plans reproduced on the page opposite, some idea of the general structural design of the hull and the arrangement of the propelling machinery will be gathered. There are ten decks, the sports, sun, promenade, upper, main, "A," "B," "C," "D," and "E" decks respectively. "E" deck is fitted only in No. 1 hold. "D" and "C" decks extend forward and aft of the machinery spaces. The "B," "A," main, and upper decks are continuous for the length of the ship. The promenade deck extends for a length of 513ft. 9in., and is the main strength deck to the hull for the midship portion of the vessel. It has on each side an athwartship overhang of 2ft. beyond the line of the hull immediately



Data for speed-power curves estimated from self-propelled tests at U.S. Experimental Model Basin with model No. 3525, using propeller No. 1803–04. Ship data:—Length, 689ft.; beam, 92ft.; displacement, 34,732 tons; trim, even keel; wetted surface, 81,410 square feet; appendages, rudder, bilge keels, thick bossings; number of propellers, 2; diameter, 19·5ft.; pitch at 2/3 radius, 19,458ft.; number of blades, 4; mean width ratio, 0·24; ratio of projected area to disc area, 0·417; blade thickness fractions, 0·0535; direction of rotation, outboard.

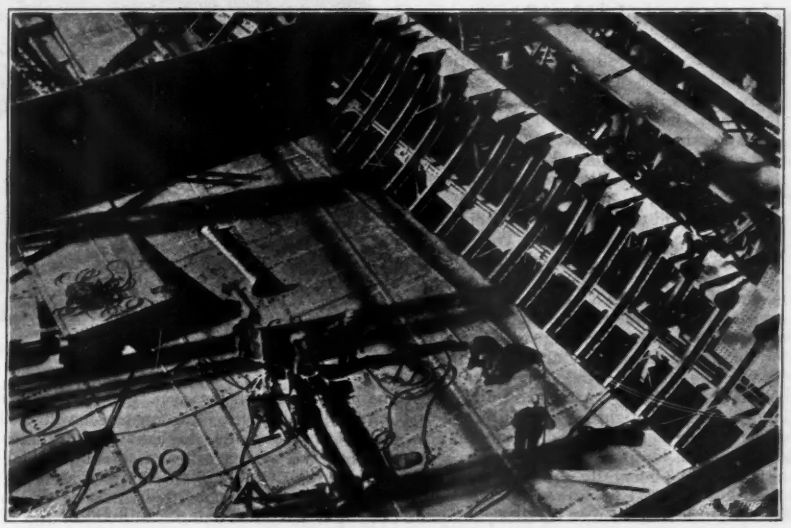
Power and Speed Curves

below. The tumblehome to the underside of the promenade deck is 3ft. 7½in.

The sun deck is above the promenade deck, and it has a length of 360ft. 8in. Above this deck there is the sports deck, which is particularly wide and spacious, and has a length of 343ft. 9in. Features of this deck are the screens for hand ball games and the two streamlined windbreaks on either side, which should help to make the deck usable for deck games in all but the worst of weather conditions. The care which has been devoted to the design of the funnels deserves some mention. The main funnel, at the centre of the ship, has Vortex soot collectors fitted to the six boiler uptakes, and both funnels—the forward one is a dummy and is used to house the emergency generating installation and battery room—are provided with a special Sampan top, having a vertical fin edge with two flat projecting wings at the rear. With these arrangements it is expected that the sports deck will remain clear of smoke and grit.

Frame Spacing and Girder System

No expansion joints are fitted in the superstructure, the deck plating being increased in thickness as necessary to function as a part of the main hull girder system. The resulting stresses are considered to be conservative and within good practice limits for medium steel. No special steels are used in the vessel.



VIEW OF "D" DECK AMIDSHIPS

All double-bottom tanks amidships are for fuel oil or oil ballast. Water is carried in the double bottom forward and aft. There are thirty-five double-bottom tanks in all. The placing of all fuel oil amidships increases the speed of provisioning the ship and minimises the piping required. The peak tanks are piped for both fresh and salt water.

In one of our illustrations on this page we show a construction view of "D" deck, which also shows a side framing and one of the watertight bulkheads.

The frame spacing amidships is 36in., decreasing forward by 1in. gradations at one-fifth length from the forward perpendicular to 27in., and decreasing further at one-fifteenth length to 24in. Aft at nine-tenth length from the forward perpendicular the spacing decreases to 24in. by 2in. gradations. The side framing consists of channels, in general 10in. deep up to "C" deck and 8in. deep to the promenade deck. The frames are joggled throughout, no liners being fitted. Web frames in conjunction with stringers are fitted in No. 1 and No. 2 holds, owing to the long span. Deep web frames are fitted in way of the bossing in order to minimise vibration.

Considerable care was taken in planning the subdivision arrangements, and the ship is fitted with fourteen transverse watertight bulkheads. These extend at the ends to the main deck, and in the way of the machinery space to "A" deck. There are fifty-nine watertight doors, all but two of which are power operated from the bridge. The fifty-seven power-operated doors are all of the horizontal sliding type and are actuated hydraulically. Two independent hydraulic systems are provided, each complete with its accumulator tank and motor-driven hydraulic pump, so that the possible failure of a pipe, by collision or otherwise, should not lead to the complete dislocation of the system.

Other safety equipment includes the lifeboats, sixteen of which are mounted in gravity type davits at the sports deck level. They are among the largest ship's lifeboats built in America. There are also included life-saving jackets and the floats, several of which have automatic lights for night rescue work. All this safety equipment conforms to the requirements of the United States Bureau of Marine Inspection and Navigation.

Hull Castings and Deck Machinery

The stem of the vessel has a cast steel forefoot, which is fitted with an extension for paravane gear, and has a rolled plate upper section well rounded. The stern frame consists of five steel castings, weighing a total of 41 tons, and two gudgeons for the rudder are provided. A spectacle frame of the "clear-water" symmetrically streamlined type is used, and it is composed of two steel castings bolted together through the centre vertical keel. The trailing edge is well tapered and fined to a radius of ⅛in. at the edge. The total weight of the spectacle frame castings is 65 tons.

There is a cast steel bower hawse pipe on each side of the ship. Each has an inside diameter of 26in. and weighs about 7 tons. The two bower anchors each weigh 21,560 lb., and the spare anchor 18,340 lb. All anchors are of the stockless pattern. The bower chains are each 165 fathoms long and are of the 3in. wire diameter stud link type. The two bower windlasses are direct geared and are each driven by a 160 B.H.P. motor. Each windlass is designed to raise its anchor and 30 fathoms of 3in. chain at an average speed of 5 fathoms per minute. The stern anchor is also of the stockless type and weighs 7805 lb. It has a 120-fathom chain of 1⅛in. wire diameter stud link design, and is worked by an electric motor-driven windlass having a raising speed of 5 fathoms per minute. The stern hawse pipe has a diameter of 18in.

The rudder is semi-balanced, with a double-plate streamlined airfoil design. It is built up from steel castings, and structural steel members, and welded. Its area is approximately 425 square feet and the solid stock has a diameter of 24½in.

The main steering gear is of the hydro-electric type with two pairs of cylinders and two double 18in. hollow rams arranged on "D" deck. Each pair of cylinders is self-contained on one bedplate. Each double end ram is connected to the rudder crosshead by double links. The steering gear is designed to operate the rudder from hard-over to hard-over in 30 sec., with the ship going ahead at 23·5 knots.

The masts and kingposts incorporate special features. The two masts have telescoping topmasts and are radio and signal masts only, with no cargo gear on them. The kingposts forward, one port and one starboard, each carry one 5-ton and one 10-ton boom on the forward side over No. 1 hatch and two 5-ton and one 20-ton boom on the after side over No. 2 hatch. The fact that one boom forward on each side is of 10-ton size is for the purpose of handling the spare anchor. The two kingposts aft, one port and one starboard, each carry two 5-ton booms forward and two aft over Nos. 5 and 6 hatches. The first hatch is for cargo and baggage; the second is the mail hatch, which has a partition in the middle to aid in segregating the mail for different ports of call. Nos. 3 and 4 hatches each have two 3-ton jib cranes and cargo ports on "B" deck. Each cargo port has a hinged platform which may be rigged outside to assist in receiving lightened cargo. The ship's refrigerated and other stores are loaded through stowing ports on "C" deck.

There are twenty cargo winches driven by 35 H.P. motors. Four of the winches are placed

below decks for serving cargo cranes. The remaining sixteen winches are on the weather deck for serving the cargo booms.

Refrigerating Machinery

As will be seen from the plans reproduced on page 158, the refrigerating plant is housed in the compartment abaft the after boiler room. The refrigerated cargo spaces forward on "D" deck are all water cooled, and are arranged for temperatures as low as 10 deg. Fah. Each space is insulated with Johns-Manville BX-4 fireproof material, between the frames or beams, and is covered with ¼in. steel plating. The ship's cold store spaces, which are arranged on the "C" and "D" decks aft, are all brine cooled, and are designed for operating temperatures from minus 10 deg. up to 45 deg. Fah. They are lined and insulated in the same way, and all the material used is incombustible.

(To be continued)

An Improved Light Source

With the object of introducing possibilities of changing the whole aspect of industrial, commercial, and decorative lighting, the British Thomson-Houston Company has produced a new Mazda fluorescent lamp, rated at 80 watts, 200–250 volts. Consisting of a slender 5ft. glass tube, it provides a richly glowing light of daylight quality from its entire surface at high levels, and at reasonable cost. Coloured objects are said to be seen in all their vividness and their outdoor appearance. The light is produced through the agency of invisible radiation, acting on fluorescent powder coated on the inside of the tube, the powder being a highly effective converter of invisible energy into visible light.

Many operations require lighting which is well diffused and of daylight quality, although hitherto it has rarely been possible to provide such light in an efficient manner. But the 80-watt Mazda fluorescent lamp is claimed to enable lighting installations to be properly designed and carried out at minimum cost. As the light from the lamp is very similar to north sky daylight, the light generally recognised as most suitable for all kinds of tasks is now available. With a low surface brightness of about 6 candles per square inch, perfect diffusion is readily obtained without complicated shielding of the light source from a glare point of view. For the same reasons shadows are practically non-existent. The efficiency of the lamp is 35 lumens per watt, which is approximately three times that of a gas-filled lamp and five times that of such a lamp with a daylight bulb.

The lighting field for which this lamp is claimed to be suitable can be broadly divided as follows:—(*a*) Industrial lighting, where the Mazdalux industrial reflector can be used in the majority of cases, as, for example, the local lighting of benches, the local lighting of machines, lighting of metal work, lighting for commercial colour matching, and lighting of drawing-offices; (*b*) commercial lighting, where standardised designs of fixtures of a more decorative character can be used, and lighting of shop interiors, display counters, shop windows, showcases, art galleries, offices, &c.; and (*c*) architectural lighting, where the lamps would be built in as part of the integral construction and where special designs of fixtures are required for each installation.

The Mazdalux reflector has been designed for use with the 80-watt Mazda fluorescent lamp. Constructed from sheet steel, this reflector is supplied complete with fixing clips for the lamp and with suspension fitments. The control unit and the power factor correction condenser are enclosed within a box mounted on top of the reflector. A cable from the control box to the lampholders is protected by detachable channels, and the unit is supplied completely wired and ready for use. A paint finish renders the reflector durable in service, the standard colour finish being white inside and green outside.

A series choke, a starter switch, a suppression condenser, and a power factor correction condenser are associated with the lamp and to simplify erection of the equipment, the first three items are assembled together to form a complete unit. There is said to be no comparison between this new light source and any other daylight lamp on the market. The lamp is said to provide daylight at an efficiency not approached by any other practical artificial source of illumination, it being three times as efficient as an ordinary gas-filled and five times as efficient as the daylight gas-filled lamp. Moreover, the amount of heat it produces is only one-third as much as that of a gas-filled lamp giving the same amount of light, a feature of great importance when the lamp is used in air-conditioned interiors. When lighted, the lamp can be handled without the slightest discomfort. It has a low surface brightness and no glare, and its light is said to permit of unparalleled efficiency in colour matching and discrimination. In the accompanying illustrations are shown a bench for the assembly of small parts lighted by Mazda fluorescent lamps in Mazdalux industrial reflectors, and a drawing board lighted in the same way. Owing to its length, the lamp can be placed behind the draughtsman, whilst illuminating his board without shadow.

FLUORESCENT LAMP

LIGHTING FOR AN ASSEMBLY BENCH

Daylight Illumination

We have received the following note from the Superintendent, Light Department, National Physical Laboratory:—

The attention of the Department of Scientific and Industrial Research has been called to apparent differences in the findings of Illumination Research Technical Papers Nos. 7, 12, and 19, and it has been asked whether these differences can be reconciled, or whether No. 19 supersedes the earlier papers Nos. 7 and 12.

It may be recalled that paper No. 7 ("Penetration of Daylight and Sunlight into Buildings"), which was first published in 1927, is largely concerned with the calculation of daylight factors, and a "minimum tolerable" value of daylight factor of 0·2 per cent. is proposed. Substantially the Illumination Research Committee, in publishing this paper, endorsed the views expressed by one man with long experience of illumination problems. It is made clear that a higher standard is required for certain purposes; for instance, a daylight factor of 0·5 per cent. is mentioned as that on the worst desk of approved elementary school class rooms.

Paper No. 12 ("The Daylight Illumination Required in Offices"), issued in 1931, gives the views of a "jury" composed of architects, illuminating engineers, an accommodation officer of H.M.O.W., and an engineer, on the minimum tolerable daylight factor for a number of rooms of various shapes and sizes; the view of the occupier of each room was also obtained. The value reached was substantially 0·2 per cent. These rooms were used for ordinary writing.

Some misapprehension has arisen from a wrongly worded sentence in this paper. The "jury," of which the author of the paper was not a member, were investigating minimum tolerable values of daylight, and did not express the view that natural lighting in a clerical office may be regarded as adequate where the daylight factor is equal to or exceeds 0·2 per cent. It is noteworthy that such a view was expressly rejected by the International Commission on Illumination when it discussed problems of interior illumination in the same year.

The investigation of 1937 described in paper No. 19 ("Daylight Illumination Necessary for Clerical Work") differed from the other two in that the workers themselves in the normal course of their duties provided—perhaps unconsciously—the data on which the conclusions were based. The value reached—5 foot-candles—corresponds to a daylight factor of 1·0 per cent. on a dull day when the outside illumination is 500 foot-candles. The work concerned was typewriting, and this word could with advantage have replaced clerical work in the title. In view of references in the paper to artificial illumination it may be well to state definitely that the conclusions reached in the investigation related to daylight.

It is probably fair to say that in the first two investigations the emphasis has tended to be on illumination that is inadequate for clerical work and other purposes that may be classified as stationary, and in the third on illumination needed to carry through typewriting and other rapid operations efficiently. As might be expected the personal factors, as revealed in the second and third papers, are rather large, but there is no reason to suppose that the third misrepresents the standard of illumination that should be secured for typewriting and similar work. Such operations necessitate a higher minimum of illumination than comparatively slow processes such as handwriting. It is not surprising that the standard of illumination generally expected—and now easily obtained—has risen. The position was summarised concisely in the chairman's prefatory note to the last of these papers: "Some of the minimum standards of illumination suggested in the past are much too low." This, of course, does not imply that there are no conditions for which a lower standard of illumination than is necessary for efficient typewriting is adequate. Much more work, preferably on a scale large in comparison with the investigations made hitherto, is needed before we are entitled to suppose that our knowledge of these problems is sufficient for practical needs.

Canadian Engineering News

Algoma Developments

The Algoma Steel Corporation, Ltd., recently placed an order for one 18½in. and 30in. by 44in. three-high roughing sheet bar breakdown water mill, to be added to a new building programme now under way there. This mill will be driven by a 600 H.P. motor through a 10 to 1 ratio single-reduction gear. It is designed to increase breakdown production by approximately 50,000 tons annually. It is to have automatic roller and catcher tables to permit the mill to roll 70 tons per eight-hour shift.

The sheet or tin bars are to be heated in a continuous gas-fired furnace at approximately 1550 deg. Fah. and delivered to the mill in pairs, to be given two single passes and three matching passes, or a total of five passed per pair. The maximum thickness of bar on the jump type mill will be ⅝in., which it will be possible to roll down to approximately $\frac{1}{16}$in. in thickness.

The mill will be equipped with a hand-operated screwdown. The bottom roll only will be driven through a universal type spindle. The roll speed will be approximately 30 r.p.m. The top and bottom rolls will be equipped with fabric water lubricated bearings. The middle roll is to be equipped with

anti-friction roller bearings. The top, bottom and middle rolls are to be equipped with three-station water control over their entire bodies, with valves situated conveniently to the screw operator, to control the shape of the bar, preferably by water instead of crowning or convexing the middle roll. The middle roll is to be equipped with an adjustment to facilitate lateral alignment, so that the centre may be placed toward the furnace side of the mill. This is done principally to control shape and to lay the bar properly on the tables.

According to the design, certain new mechanical features have been incorporated on the new jump type mill that permit changing of the middle roll in four minutes. With the new design it is not necessary to remove spindles, spindle carrier or drags in order to change the bottom roll ; consequently the changing of all three rolls is accomplished in less than forty minutes. There are no heavy chock clamps or bolts on the outside face of the housing for retaining the roll chocks, thus eliminating the breakage of clamps or studs.

The new roller and catcher tables have been designed for high-speed fast chain reversal and quick tilting and retarding motion of the catcher's table. They are so arranged that all motors and electrical equipment are accessible from the floor. A new side guard operating mechanism has been incorporated, whereby only one adjustment is required for widths and the side guards need only be changed for widths of 6in. intervals. All moving parts of the tables are mounted upon roller bearings and lubricated from accessible points. All table parts operated in water or heat are of special rust-resisting alloy. Convenient and quick adjustment of tables to facilitate up-and-down movement of the mill rolls and in-and-out movement to and from the mill rolls is done by means of hand wheels and ratchet wrenches, easily accessible from the operator's position. Both table operators can view all moving parts and all operations. The screw operator has all water valves conveniently located on his side of the mill. One operator is required for each table, one operator for the screws and a furnace operator. Foot switches and table control are used in connection with finger-tip emergency control for the operation of table chains and furnace doors and are placed convenient to the table operator's swivel seated position.

The new mill is being constructed by the Lewis Foundry and Machine Division of Blaw-Knox Company, Pittsburgh, P.A., associated in Canada with the Canada Iron Foundries, Ltd., Three Rivers, Quebec.

New Measuring Instrument

With a view to speeding up the preparation of forestry maps from air photographs, the Dominion Forest Service of the Department of Mines and Resources, Ottawa, has developed the photo-electric planimeter, an instrument which measures map areas two or three times as rapidly as the ordinary planimeter. Although it is only in the experimental stage, results show that the photo-electric planimeter is highly accurate. This accuracy will be still further increased when certain proposed improvements have been incorporated in the instrument. The principle utilised in the photo-electric planimeter is based upon the action of photo-electric cells in producing an electric current when subjected to light. Light coming from an illuminated surface is measured by the current it produces in the photo-electric cells. The area to be measured is cut out of a map which has been blackened on the back, and the cut-out is placed between an illuminated surface and the photo-electric cells. Thus the light reaching the cells is reduced in proportion to the size of the blackened area interposed, and the measurement of this reduced light enables a computation to be made of the size of the area.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

BLACK BOLTS

No. 916. To secure the utmost economy in steel consumption the British Standards Institution is co-operating with the Ministry of Supply by revising a number of the existing British Standards and by preparing new "War Emergency" Standards. One such War Emergency Standard has recently been issued for Black Bolts and Nuts. This Specification, which is additional to the well-known B.S. 28 for Black Bolts and Nuts of "Whitworth" dimensions, provides for black bolts having heads and nuts smaller than the full Whitworth sizes. The specification has been prepared at the request of the Ministry and in full consultation with the manufacturers, and it is estimated that the manufacture of bolts and nuts to this new standard will effect a saving of some 60,000 tons of steel per year. The dimensions of the heads and nuts are those of the next smaller nominal size in the "Whitworth" series, and permit of the use of existing spanners. The dimensions are therefore in effect those which have been long recognised for bright B.S.F. bolts and "Auto-Whit" bright bolts as laid down in B.S. 191 and B.S. 193. Provision is made for both the B.S. Whitworth and B.S. fine thread.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The General Position

Iron and steel masters in all parts of the country are distinctly perturbed over the latest attempt on the part of the railways to secure authority to advance their charges still further. Unless this tendency is strongly discouraged, it seems inevitable that a vicious spiral of higher prices for most commodities will follow. Meanwhile, activity at the steel works is intense, and it looks as if they will not be able to increase their outputs further without the laying down of additional plant. This is a step which cannot lightly be undertaken, since, apart from the difficulties of securing material for their erection, it is uncertain to what extent such new works would continue to find employment after the cessation of hostilities. The Iron and Steel Control has made no new Orders of importance during recent weeks affecting the trade, but the latter is already very closely regulated, both as regards prices which may be charged and the users who may be supplied. Unless a consumer is in a priority class, engaged on official war work, it seems almost impossible to obtain steel supplies at the moment. The Government's declared policy is to foster exports, but with so much steel needed at the moment for our armaments drive, there is so far not much material to spare for overseas markets. Naturally in these circumstances the United States is receiving more business for export than in the ordinary way, though, of course, many markets are closed by the British blockade. Britain is guaranteed a steady stream of steel supplies, particularly semis, from America under big contracts placed by the Control.

The Pig Iron Market

Most pig iron consumers in this country engaged on essential production are receiving adequate supplies, but for non-essential purposes they are not so fortunate, and can only obtain pig iron sparingly, owing to the close supervision authorised by the Control. The whole industry has been so geared into the war effort during the past year that the majority of manufacturing plants seem to be connected one way or another with Britain's military effort. In the North-East coastal district the blast-furnaces are mainly producing basic and hematite iron, so that foundry pig iron has to be brought into the district from the Midlands. The hematite supply position makes it necessary for this variety to be rationed carefully. Prices of pig iron throughout the country are steady at the official levels, although, unless the railways' applications for higher rates are rejected, a further advance may become necessary. The general ore supply position is satisfactory, since while it is true that the output of the British mines has been considerably enlarged, we are still able to obtain ore from Spain and Morocco. There is also no shortage in the coke supply. In the North-West Coast district the local consumption of pig iron is heavy, and there is now somewhat less iron available for dispatch to other parts of the country. In Lancashire a better demand is reported for foundry pig iron, owing to the improvement in the light castings industry. South Wales reports a keen demand for the local product. In the Midlands generally there has been no change in the pig iron situation. The demand, particularly for special pig irons such as hematite and low phosphorus iron, remains intense, and consumers of all grades are being rationed. In Scotland the light castings industry seems to be lagging behind, employment being patchy, and this affects the demand for foundry iron adversely. Owing to the rationing scheme, however, consumers cannot build up stocks of foundry pig iron against their winter requirements. Some hematite and basic pig iron is being imported from abroad to add to the local Scottish output.

The Midlands and South Wales

The demand for heavy steel in the Midlands remains intense, and there is a tendency for it to increase further until the armaments drive reaches its peak. Structural material in particular is in keen request, whilst there is a growing demand for special steels needed for guns and aircraft. The present rationing scheme, with its system of symbols and priorities, seems to be working fairly well so far. The position of the Midland re-rolling plants has improved somewhat now that larger supplies of imported semis are coming forward. The employment of the latter works at a high rate is, of course, important from the point of view of the national war effort, as they can relieve the pressure on the heavy steel works. There has been no change in the Midland pig iron situation, and a good demand, both on local and outside account, has to be filled. In South Wales great activity is also the rule, and the works report that the necessary raw materials are coming forward at a more satisfactory rate. Enormous tonnages of heavy steel are being actively absorbed by the shipyards and engineering works. Billets, sheet bars, and tin-plate bars are in good demand, though the rate of activity in the tin-plate trade has declined somewhat. The black and galvanised sheet mills continue extremely busy on priority contracts.

Scotland and the North

The tremendous and sustained activity which is the rule to-day in the Scottish industrial areas represents an achievement both on the part of the Control and of steel masters in view of war-time difficulties. The Control has had to make new arrangements to compensate for the loss of certain sources of supplies of raw material, and the steel makers no doubt have their own domestic war-time troubles. Practically all the contracts in hand are directly or indirectly on Government account, and only priority consumers are now allowed any substantial tonnages. There is understood to be plenty of export inquiry, but owing to the strict supervision of deliveries by the Control, only a fraction of this can at present be satisfied. It is hoped, however, that in due course it will be possible for the mills to pay more attention to overseas business, as markets once lost are often hard to recapture from foreign competitors. There is a keen demand for special steels for shells and aircraft manufacture, and plates, sheets, and sections are being eagerly absorbed by the busy ship-building yards and structural engineers. Makers of railway rolling stock, including trucks and locomotives, are taking up large quantities of plates and thick sheets. The tube mills are also extremely busy. The re-rolling mills are actively employed turning out steel bars, strip, and small sections, and are using considerable tonnages of imported semis, which are coming forward in gratifying quantities, chiefly from the United States.

Copper and Tin

It became known a few days ago that the Ministry of Supply's contract with Rhodesian producers for 265,000 tons of copper will be renewed for a year from the present month. This tonnage, of course, is the basic quantity, and during the twelve months just ending actual supplies were much in excess of that figure, an additional quantity of between 50,000 and 100,000 tons having been supplied. It is to be presumed, therefore, that similar additional purchases will be made during the current year. Consumption in Great Britain continues high, but supplies are adequate. In this connection it is interesting to note that in July the United States shipped nearly 19,000 tons of copper to England, compared with 14,200 tons in June. This metal was mainly copper refined in bond from imported ores, and probably included a good deal of copper from the Belgian Congo. The American market continues firm. Domestic consumption shows an upward tendency, whilst with Japan inquiring for prompt shipment the export market has also had a stronger tone. . . . Tin prices here have continued to drift slowly downwards owing to regular offerings by producing interests on a market largely without support. It is now believed, however, that export licences will shortly be granted more freely by the authorities, in which case a stiffer tone might develop, as once metal is available for export there is no reason why the London market should not achieve, at any rate, parity with New York, bearing in mind that the actual price level would remain much lower in England owing to the high costs of transport and insurance. The United States market, also, has continued dull. The tin-plate trade in America is passing through rather a quiet time at the moment, whilst motor-car makers are also buying little, and in a number of instances are preparing to turn over to Government work in connection with the rearmament programme. According to the International Tin Research and Development Council, the world's output of tin in July was about 18,800 tons, compared with a revised figure of 20,100 tons in June, making a total for January–July of 124,400 tons, compared with only 77,600 tons in the corresponding period of 1939. At the end of July Bolivia was nearly 12,000 tons behind her quota, and Malaya 2500 tons in arrears. Nigeria, however, had over-exported to the extent of 2363 tons.

Lead and Spelter

The demand for lead in this country for essential requirements continues at a high level, and battery and cable makers remain actively employed on Government work. A certain amount of business is passing in lead pipes and sheets for Government and industrial building ; but the quantities absorbed in this direction are far smaller than in peace time as the principal outlet for lead pipes, at any rate, is in the construction of dwelling-houses. There has been some expansion in the consumption of chemical lead for lining acid vats, &c., but the quantities thus absorbed are not large. A moderate export business appears to be passing in lead products and corroded lead, as in view of the reasonable levels at which pig lead prices are controlled here British manufacturers are well placed to compete in the overseas markets which remain open, especially as some of their principal competitors are not able to operate. . . . The general position of spelter has not altered much in the last week. Adequate supplies are available for all priority requirements, which remain on a large scale, and reasonable quantities are also being allotted for the export trade. Home consumption for non-essential purposes remains restricted, but there is no doubt that the position of supplies now is better than at any time probably since the war began. Now that the Control is not called upon to help France the maintenance of sufficient supplies of metal to meet all urgent requirements is assured. High grade metal continues particularly in request in connection with the war effort.

Non-ferrous Metal Prices

The London Metal Exchange official statement, containing the average prices for tin during August, shows a decline in the settlement price of that metal of £3 3s. 10d. compared with July. For cash tin the average price is £3 2s. 10d. lower and for three months £2 8s. 3d. below the average for the previous month. The statement also gives the official maximum prices for copper, lead, and spelter, as fixed by the Controller of Non-ferrous Metals, and is as follows :—

Standard tin	Cash (mean)	£262	12 4 1/2
	Three months (mean) ...	£263	1 1 1/2
	Settlement	£262	10 8 1/2

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-ferrous Metals :—

	£	s.	d.		
Standard copper					
Electrolytic copper ...	62	0	0	delivered buyers' premises	
Electrolytic wire bars ...	62	0	0	,,	,,
Best selected copper ...	60	10	0	,,	,,
Lead, good soft pig (foreign)	25	0	0	,,	,, (duty paid)
Spelter, G.O.B. (foreign)	25	15	0	,,	,, (duty paid)

Notes and Memoranda

Rail and Road

AMERICAN RAILWAY PURCHASES.—According to *Railway Age*, orders were placed during the month of July for eleven steam and forty Diesel-electric locomotives, 5846 freight cars and thirty-six passenger cars. Comparison shows that each of these totals exceeds orders placed in any month this year.

COLLISION AT CUYAHOGA FALLS, OHIO.—Forty-one people were killed when a petrol-electric railcar collided head-on with a freight train on the Pennsylvania Railroad at Cuyahoga Falls, Ohio, on July 31st. It is stated that both trains were moving on a single track and that the collision caused the railcar to catch fire.

TOWER OF LONDON STATION.—The London Passenger Transport Board is now demolishing the former Tower of London Station, between Mark Lane and Aldgate East stations. This station, which was built of wood and was opened on September 25th, 1882, was closed on October 12th, 1884, and has not been used since.

LONDON BUSES AND THE BLACK-OUT.—The London Passenger Transport Board has announced that a new platform light designed specially for use on buses and trams is being fitted at the rate of 1000 a week. Trolley-buses and Green Line coaches will also be fitted with the lamp, which softly floodlights the boarding platform and the pavement near it.

L.M.S. TIME TABLE ALTERATIONS.—The L.M.S. Railway has announced various time table alterations, which came into operation on September 1st. The Irish mail is now a day instead of a night service, the down mail leaving Euston, weekdays and Sundays, at 8.20 a.m., calling at Rugby, Crewe and Chester, and arriving at Holyhead at 2.23 p.m. On Sundays an additional stop is made at Bangor. In the reverse direction departure from Holyhead is at 1.45 p.m. on weekdays, reaching Euston at 7.35 p.m., after stops at Chester and Crewe. On Sundays the express leaves Holyhead at 1.50 p.m., calls additionally at Bangor, and reaches Euston at 8 p.m. The additional trains provided on Saturdays and Sundays during the summer to and from holiday resorts will be withdrawn after September 14th and 15th.

FORMER ROYAL TRAIN ENGINE FOR SCRAP.—One of Great Britain's famous locomotives, named in honour of the coronation of King George V and Queen Mary twenty-nine years ago, has just been withdrawn as obsolete by the L.M.S. Railway, and, after all its re-usable parts have been removed, will be broken up to yield many tons of metal to the war effort. The engine is No. 25,348, "Coronation," which was the 5000th locomotive constructed at Crewe works, and which in its prime was used to haul the Royal train. Although vastly outmoded in size and power, it was used even in recent years on express work on the North Wales Coast, and when its career finally ended at Stafford it had covered 1,013,610 miles. The modern L.M.S. "Coronation" engine, built and named in honour of the coronation of our present King and Queen, is now on exhibition with the "Coronation Scot" train at the 1940 New York World's Fair.

DISPATCH OF GOODS FROM PORTS.—As a further step to prevent congestion in the ports, the Minister of Transport has given instructions that railway companies shall convey goods in open railway wagons if neither covered wagons nor sheets are available and congestion is likely to result if the goods are not immediately despatched. These instructions will, however, only become operative when a Port Emergency Committee serves notice upon a railway company that it is necessary in order to clear the port for certain traffic to be despatched forthwith. Such notice will be served only when there is a real danger of acute congestion occurring if goods have to wait until covered wagons or sheets are available, and not in cases where there is merely a day-to-day shortage. Traffic will not in future be double-sheeted. The Minister has also made an Order under the Defence Regulations relieving a railway company from liability for damage to merchandise carried unsheeted in accordance with the Minister's instructions.

HIGHWAY ECONOMICS RESEARCH.—The setting-up of a Highway Economics Division, the first "highway laboratory" of the United States, designed to gather and distribute information and data on highway construction and maintenance, has been announced by the American Road Builders' Association. The new Division will assist in stabilising road expenditures in accordance with fluctuating amounts of Federal funds, gas taxes and registration fees. It is believed by A.R.B.A. officials that more comprehensive State highway programmes will result, if accurate, up-to-date information of this nature is available. At present highway programmes are primarily based on traffic studies. The new plan is to include the effect of the highway system on the national economy. It is intended also that these studies shall be used to teach civic groups the value of highways to local business and to social, educational and cultural interests. Greater co-ordination between Federal, State and county highway agencies is expected to result from the activities of the new A.R.B.A. Division.

Air and Water

PANAMA CANAL TRAFFIC.—Ocean-going vessels passing through the Panama Canal during July numbered 431, compared with 485 for the corresponding month of last year.

MERCANTILE LOSSES.—For the week ended August 25th mercantile losses due to enemy action included thirteen British ships totalling 69,340 tons, one Allied ship of 1718 tons, and two neutral ships totalling 8692 tons. This makes a total of sixteen ships totalling 79,750 tons. Although the total tonnage lost during the week is slightly in excess of the average weekly loss since the beginning of the war, it is below the average weekly loss of British, Allied and neutral shipping since May 27th, when the enemy intensified the war on shipping.

H.M.S. "PENZANCE."—The Admiralty has announced that H.M. sloop "Penzance" has been sunk after torpedo attack. She was a 1025-ton sloop of the "Hastings" class and was completed at Devonport in 1931.

AMERICAN AIRCRAFT PETROL FOR JAPAN.—It is reported that aviation petrol is now moving in large quantities from Texas through ports on the Gulf of Mexico to Japan after a suspension of shipments on account of the United States Government's embargo of July 27th. One cargo of 770,000 gallons has been loaded on board a Norwegian ship for delivery to Japan, and it is stated that the Government's approval has been given for the shipment of a further 300,000 gallons.

HIGHER POWER FOR "WELLINGTON" BOMBERS.—It is officially announced that British long-range "Wellington" bombers have now been equipped with new engines designed to give an even finer performance. Two liquid cooled Rolls-Royce "Merlin" engines, such as are fitted to the "Hurricane" and "Spitfire" fighters, are now replacing the radial air-cooled engines with which the "Wellingtons" were previously fitted. Whilst the figures for the improved performance must remain secret, the several hundred extra horsepower developed by the new engines must add considerably to the former speed of around 260 m.p.h.

RECORD REPAIRS.—Hundreds of the engineering staff of British Overseas Airways Corporation have been lent to the Ministry of Aircraft Production for repair work, and at various centres they are engaged night and day on these activities. As an instance of the work that is being done, we learn that recently the Coastal Command had two Short "Sunderland" machines which were in urgent need of an overhaul. A call was put through to the home flying boat base of the Corporation. The aircraft were to come over at once; a thorough job must be done; they must be returned in six weeks. Six days later the overhaul was complete, and the machines were ready for collection.

SMALL RIVERS IN RUSSIA.—The territory of the U.S.S.R. contains innumerable small rivers and tributaries, which are by degrees being adapted for navigation and the flotation of timber. The total length of the small rivers now exploited in the U.S.S.R. is 5768 miles, which is but a fraction of the aggregate length of the small rivers in the Soviet Union. About 753 miles of small rivers were made navigable during the last two years. In 1940 an additional 685 miles of new waterways will be brought into exploitation. In particular, the River Alatyr will be made navigable. The plans for this year also provide for the reconstruction of two sections of the Severnaya Donets River—Veselogorsk to Slavyano-Serbsk, 20 miles, and Izyum to Svyatogorsk, 29 miles.

SHIPBUILDING IN DRY DOCK.—In this country the building of vessels in dry dock is not common practice, but in American dockyards special arrangements have been made for this purpose. *Shipbuilding and Shipping Record* mentions that the "Louisville" was the first of the U.S. 10,000-ton cruisers to be built in a dry dock specially designed and equipped for new construction. The dry dock at Puget Sound Navy Yard is a shallow concrete dock, 927ft. in length, 130ft. in width, and is of sufficient size for the simultaneous construction of two cruisers of the size of the "Louisville." The lay-out of the docks and shops, together with the transporting facilities, are considered to be almost ideal for the economical building of ships. Two principal advantages are claimed for the construction of vessels in dry dock as compared with building on inclined slipways, namely, the comparatively easy erection of the vessels on a horizontal base, and the safety and relatively low cost of floating vessels compared with the dangers associated with the ordinary launching method and the cost involved in this operation. There are thus obvious advantages in building vessels in dry dock, but there are evident disadvantages, the major one being the heavy cost involved in the building of such docks. Further, during the time a vessel or vessels are being built the dry dock is useless for other purposes. In the ordinary work connected with the maintenance of fleets, a constant demand is made for dry dock facilities.

Miscellanea

THE LATE PROFESSOR W. L. MILLER.—We regret to have to record the death, on Sunday, September 1st, in Toronto, of Professor W. L. Miller, C.B.E., Ph.D., Professor Emeritus of Physical Chemistry at the University of Toronto. He was a Past-President of the American Electrochemical Society, the Canadian Institute of Chemistry, and of the Royal Society of Canada.

UNEXPLODED CANNON SHELLS.—The Ministry of Home Security has issued a statement regarding unexploded cannon shells which fall from aeroplanes. People are warned that these shells are liable to explode if touched. The position of any such shells that are found should be marked and reported to the police, and the shells should be surrounded by loose bricks, stones or earth to avoid disturbance.

COPPER SMELTING WORKS IN CENTRAL URALS.—The Central Urals Copper-smelting Works, the largest of its kind in the U.S.S.R., situated in the heart of the Urals mining industry at Revda, 25 miles from Sverdlovsk, was recently put into operation. The plant occupies a place in the Soviet non-ferrous metal industry comparable with that of the Magnitogorsk Works in the Soviet iron and steel industry. The new plant has a capacity 1½ times greater than the entire output of copper in Russia in 1913. Copper ore will be supplied to the new plant by the Degtyarsk pyrites deposits, which contain almost half the copper ore in the Urals. Unlike other Soviet copper producers, this plant will use coal dust for firing the reverberatory furnaces. It is claimed that the plant will be able to extract no less than 95 per cent. of the metal from the ore.

TIMBER CONTROL.—The Control of Timber (No. 17) Order, made by the Ministry of Supply, came into force on Saturday, August 31st. This Order introduces an up-to-date schedule of the maximum prices for home-grown timber hitherto set out in the schedules to the Nos. 1 and 12 Orders. In general there are no changes in the prices, but in some cases adjustments are made in the prices of home-grown mining timber. The differential prices for Scottish mining timber delivered to mines in England are abolished and a transport subsidy is to be paid on long railway hauls in the United Kingdom and on sea freight from Ireland and Scotland.

NEW SOVIET PLANTS FOR ELECTRICAL EQUIPMENT.—The construction of three big plants for the manufacture of electrical equipment will be started this year by the Commissariat of the Electrical Industry of the U.S.S.R. One of these plants, to produce A.C. electric motors as well as motors for the textile industry, will be built in Siberia. A turbo-generator plant will be erected in Lysva, in the Molotov Province. This plant will produce turbo-generators ranging in capacity from 1000 to 12,000 kW, and asynchronous motors and hydro-generators of medium size. The third of the plants, which will manufacture transformers, will be built in Sverdlovsk, in the Urals.

AMERICAN COAL OUTPUT.—A summary of the weekly output of the United States bituminous coal industry has been prepared by the Bituminous Coal Division of the U.S. Department of the Interior and shows that the gross output in 1939 was 393,065,000 net tons in 305·3 days, making an average of 1,287,000 tons per day. In 1938 the output was 348,545,000 tons in 306 days, with a daily average of 1,139,000 tons. Last year the largest weekly output was in the week ended October 14th with 10,715,000 tons, and the lowest in the week ended May 13th with 1,085,000 tons. In 1938 the extremes were 8,831,000 and 4,639,000 tons in the weeks ended December 3rd and April 2nd respectively.

PRODUCING ALLOY STEEL.—A simplified method of producing alloy steels containing nickel has been developed at the Urals Branch of the Academy of Sciences of the U.S.S.R. At a recent meeting of the Academy, V. Mikhailov, of the Urals Branch, reported on this work carried out under the direction of Academician I. P. Bardin, which demonstrated the feasibility of smelting pig iron with a high nickel content in blast-furnaces. Ordinarily the alloys are produced by adding nickel to molten steel. The new process, involving the direct smelting of iron ores containing nickel, considerably reduces the cost of production. The personnel of the Nizhny-Saldinsk Iron and Steel Works collaborated with the scientists in this work.

EXPLOSION OF GREEN DEPOSIT ON COPPER CABLE.—The Liverpool and Merseyside Industrial Safety Committee reports that an electrician was repairing the cables on a main distribution box. Where one of the cables entered the terminal lug, it was covered with a green deposit which the electrician took to be verdigris. The deposit started close to the lug and extended about 1in. up the cable. The electrician proceeded to scrape this clean when an explosion appears to have occurred which temporarily blinded him. A foreign body also entered one of his eyes. Subsequent investigation showed that what the man thought was verdigris was copper acetylide, produced by chemical action between the copper of the cable and acetylene fumes given off by a nearby pickle liquor well. As copper acetylide is a detonating composition it is fairly obvious what happened.

BURSTING OF ABRASIVE WHEEL.—A note in the "Industrial Safety Bulletin," published by the National "Safety First" Association, records that a resinous bonded abrasive wheel, 16in. in diameter, in use on a swing grinder, burst into ten pieces. No personal injury occurred, as the guard caught all the pieces, which merely dropped to the floor. A new wheel was fitted and within two hours it also had burst. The machine was then carefully examined. It was driven by an electric motor through two ¾in. V belts running in grooved pulleys. The cast iron pulley connected directly to the wheel had been in use for ten years. When new, the pulley grooves were 7½in. in diameter and the abrasive wheel then ran at a peripheral speed of 8500ft. a minute. (The maker's speed for the wheel was 8700ft. per minute.) During ten years' use the friction of the two V belts had worn the grooves down until their actual diameter was only 6½in. In other words, ¾in. had worn off all round the grooves. As a consequence, the peripheral speed of the wheel had increased from 8500ft. to 11,332ft. per minute. It may be noted that Regulation 9 (*a*) of the Grinding of Metals Regulations and Regulation 13 (*a*) of the Grinding of Cutlery and Edged Tools Regulations require that the pulley diameters necessary to secure the safe working peripheral speed be specified in a notice. These diameters are the actual diameters for use, and not merely the original ones when the plant was new. The accident illustrates the effectiveness of a really good guard. Despite two bursts no personal injury was caused.

PERSONAL AND BUSINESS ANNOUNCEMENTS

MR. ROBERT CRICHTON, C.B.E., of Derwent Lodge, Cockermouth, has been appointed to the Board of the Blaenavon Company, Ltd.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., has been appointed by the manufacturers of the Spekker Stelloscope, Adam Hilger, Ltd., of London, to be distributor of this instrument in the United Kingdom.

SIEMENS-SCHUCKERT (GREAT BRITAIN), Ltd., has come to an agreement with Mr. Victor Stobie, M.I.E.E., of Dunston House, Harrogate, to manufacture under an exclusive licence high-frequency furnaces to his patents.

MR. G. R. T. TAYLOR has resigned his seat on the boards of Vickers, Ltd., and English Steel Corporation, Ltd. He retains his directorship of Taylor Bros. and Co., Ltd., which company is a subsidiary of English Steel Corporation, Ltd.